OCT 19 1935

Engineering News-Record

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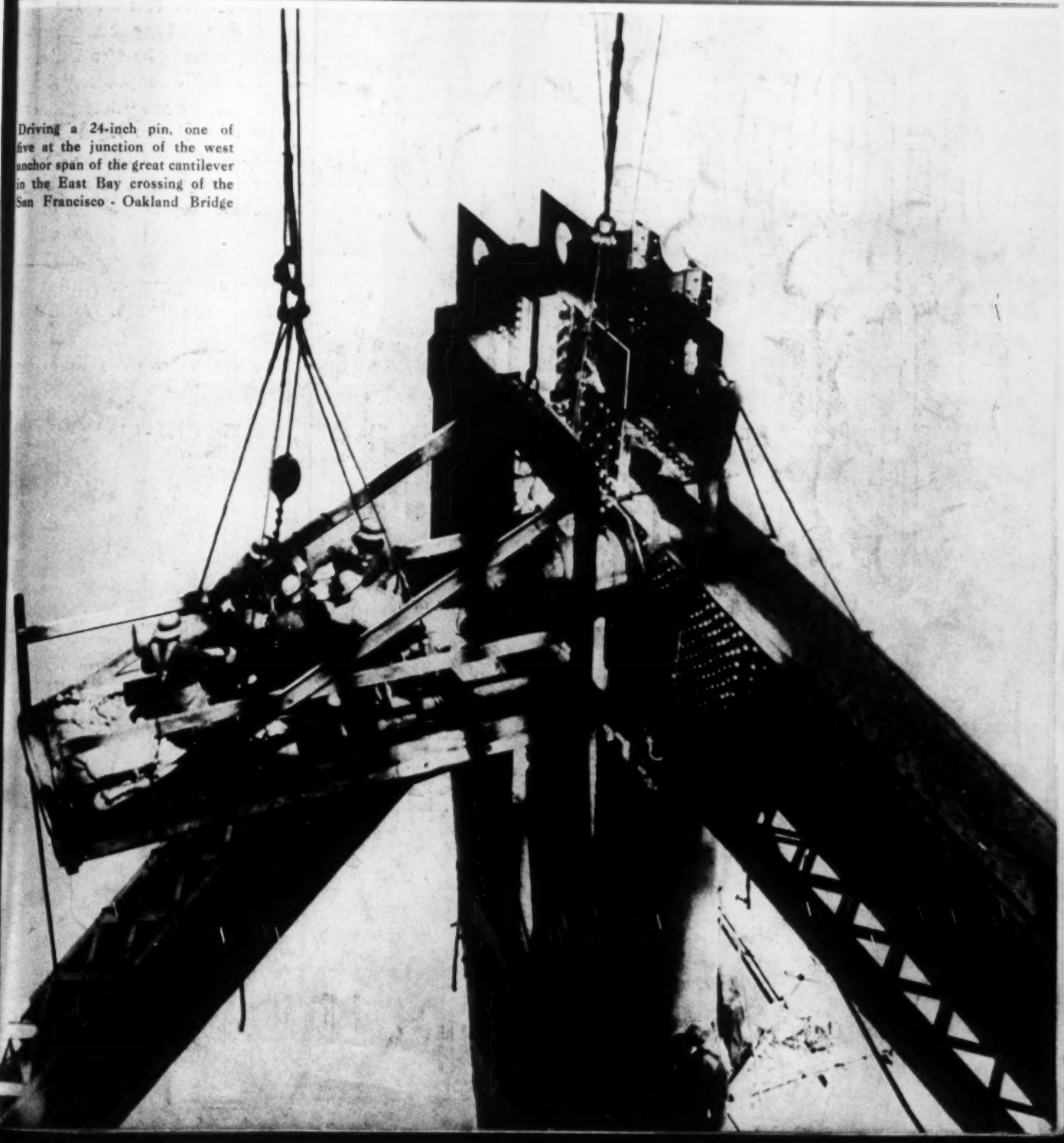

Driving a 24-inch pin, one of five at the junction of the west anchor span of the great cantilever in the East Bay crossing of the San Francisco - Oakland Bridge

THEY'RE PARTIAL TO SHOW-DOWN ECONOMY

Nine **out of** ***ten*** **tractors at work on the biggest construction projects in the United States are "Caterpillars." Over half of these are "Caterpillar" Diesels and the figures are shifting in favor of the Diesel model every day. . . . The contractors say it's** ***economy,*** **above all else, that puts the "Caterpillar" Diesel in their equipment. And the "Caterpillar" SHOW-DOWN proves it! Caterpillar Tractor Co., Peoria, Illinois, U. S. A.**

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D I E S E L

The "Caterpillar" Diesel Seventy-five Tractor and "Caterpillar" Grader—an unbeatable team for road construction at lowest possible cost. Here it is banking a grade on a highway near Joplin, Mo.

Cheering Sections *or* Blacksnakes?

IT is a maxim that the function of the army and navy is to make good on the blunders of statesmen. Once this applied only to international relations; now the army is called in to retrieve some domestic blunders of the statesmen—to say nothing of the politicians and the social workers.

Officers now have been detailed from the Corps of Engineers to help put some order into the work-relief mess. From the reports one cannot discern just how broad is to be the scope of their influence. If they are in position to do a thorough job that is one thing. But if they are to be hog-tied by the WPA philosophy that sacrifices all respect for public economy and efficient performance in favor of time-serving and wasteful employment they will have little chance to perform in keeping with the enviable record of the Corps. But this is no worry for a civilian: it is to be expected that the Chief of Engineers knows his way about Washington well enough to keep his men from being maneuvered into so untenable a position.

OF course, some of his officers already are sitting on hot spots through no fault of their own or of his. After all, they are soldiers and when their orders not only assign a mission but also prescribe tactics in detail, they are in for it. As soldiers and engineers, their sense of administrative and economic responsibility may be outraged but "orders are orders" and that's that. Yet, some of them must feel pretty sick about their present assignments and it is to be hoped that Corps influence at the top of WPA will result in removing some of the handicaps now imposed upon officers who must work under its control. For example, consider that Florida Ship Canal. No one who knows the officer in charge of that job doubts his will or ability to prosecute it efficiently. But what a salty assignment for any man brought up with a respect for sound principle and efficient performance!

It is quite impossible to keep step with the giddy whirl of WPA regulations and revisions but at this writing some of the specifications on that job violate every requirement of productive efficiency. The decision to advertise for contractors' bids was a gratifying recognition of normal practice but it was sadly qualified by the traditional WPA restrictions as to man-hours per unit of cost, use of relief-labor and all the other devices shrewdly designed to increase labor and curtail output. And public administration reached an all-time low when it hedged between downright job-making and efficient production by requiring of the contractor adequate equipment "to insure completion of the work within scheduled time," while it warned him that this requirement might not be used "to handicap the use of manual labor necessary to meet the specified man-year rate of employment."

No wonder one contractor estimated that he might land the job if he figured on using competent men at regular wages with adequate equipment to build the canal, and on hiring his quota of 30-cent relief labor to stand along the banks and cheer the workers. Thus he would have a job, competent men would get employment and the taxpayers would get a better canal within the prescribed time limit at a lower cost. The cost of the "cheering section" could be charged to relief and while the total cost of the project appears to be of no concern to anyone, the public at least would have known how much it paid for canal and how much for relief. Or can it be that the only equipment contemplated is a reincarnated Simon Legree and a blacksnake whip?

DURING the last two years a harassed construction industry has labored consistently in behalf of sound procedure on the public works program. At times good sense seemed to prevail, eventually to be eclipsed by the assignment of WPA to dominate both public works and work-relief. The present call on the Corps of Engineers may foreshadow the passing of relief domination and an escape from the necessity of choosing between cheering sections and blacksnakes in the conduct of public construction.

If that be the case and if the officers now assigned to WPA can reestablish sound practice in the administration of a public works program, they will be doing a good job for the industry and for the country.

Willard Chevalier

ENGINEERING NEWS-RECORD

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Break the paralyzing grip of winter ice with SALT

Every year more streets and highways are made safe for winter traffic with rock salt. Every year more street and highway officials learn that rock salt is the best, as well as the cheapest, means of ice control.

At usual winter temperatures rock salt will melt more ice per pound than other chemicals commonly used. It is itself an abrasive. This makes it more efficient when used alone or as an embedment agent with other abrasives. Rock salt is also much lower in cost than other suitable chemicals.

Out of three great International mines there pours every year, a tremendous quantity of rock salt for icy highways. Long before winter storms strike, it is stored at strategic points by county, state and municipal highway authorities. International's modern mines and great facilities play an important part in providing rock salt for convenient and economical icy highway safety.

The International Salt Research Laboratory has made important contributions to the knowledge of how salt can best be used on streets and highways. Engineers, state and municipal officials are invited to submit any question about rock salt for icy highway use, to the International Salt Advisory Service, without cost or obligation. A technical bulletin on the advantages of rock salt and ways of using it, will be sent free on request.

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In the News:

THE QUEENSBORO BRIDGE in New York is one of the most heavily traveled bridges in the country. Last week its deck was divided into five lanes by means of painted stripes and traffic lights. Traffic must stay in line. Preliminary results show a reduction in accidents and a speeding up of traffic. The experiment will be continued for thirty days.

A SERIES OF EARTHQUAKE SHOCKS in and around Helena, Mont., last Saturday caused damage to a number of buildings. Walls were cracked, chimneys thrown down and much glass broken.

SCHOOL BUILDINGS will comprise half of the PWA program, 2,133 such structures having been approved for allotments of $130,696,188.

THE TIDES OF PASSAMAQUODDY, where the federal government's "tide harnessing" hydro-electric project is getting under way, put on a show of power last week end. Saturday they registered a 50-year low, permitting waders in hip boots to cross the bay, and on Sunday they rose to the unprecendented height of 28.8 ft., according to an *AP* dispatch.

AUTO DEATHS IN 1934 were the highest on record according to the U. S. Bureau of the Census. The total was 33,980, or at a rate of 26.9 per 100,000 population. The 1933 rate was 23.3.

A PLAN FOR CERTIFICATION into the engineering profession put up to the engineering societies last year by the Engineers Council for Professional Development has been sidetracked by being referred back to committee for further study. Such strong opposition to the plan developed as to threaten the whole E.C.P.D. movement.

ESTABLISHMENT of satisfactory standards of water cleanliness was called for at the Public Health Engineering Section of the American Public Health Association at its meeting in Milwaukee last week. The many existing requirements result in needless confusion, the engineers said.

MONTREAL has decided to call for bids on a new water intake in the St. Lawrence River after months of discussion centering on whether the difficult and expensive task could be avoided. The work will cost about $1,500,000.

In This Issue:

FLOODS IN East St. Louis, Ill., are particularly disastrous because of the heavy concentration of industries and railroad yards in the Mississippi River bottoms. Cahokia Creek, the worst offender, is being placed in a widened open channel and a three-box concrete culvert near its mouth, cutting off two miles of its present meandering route. A pumping station at the Mississippi River levee is also included.

AN UNDERSTANDING of contract law is a distinct asset to the carrying on of a construction business. One of the important questions that must often be faced is: Under what conditions is a contract legally impossible to perform? Nathan Young, a member of the New York Bar, in two articles beginning this week, cites a number of decisions that should aid contractors in broadening their acquaintance with an important subject.

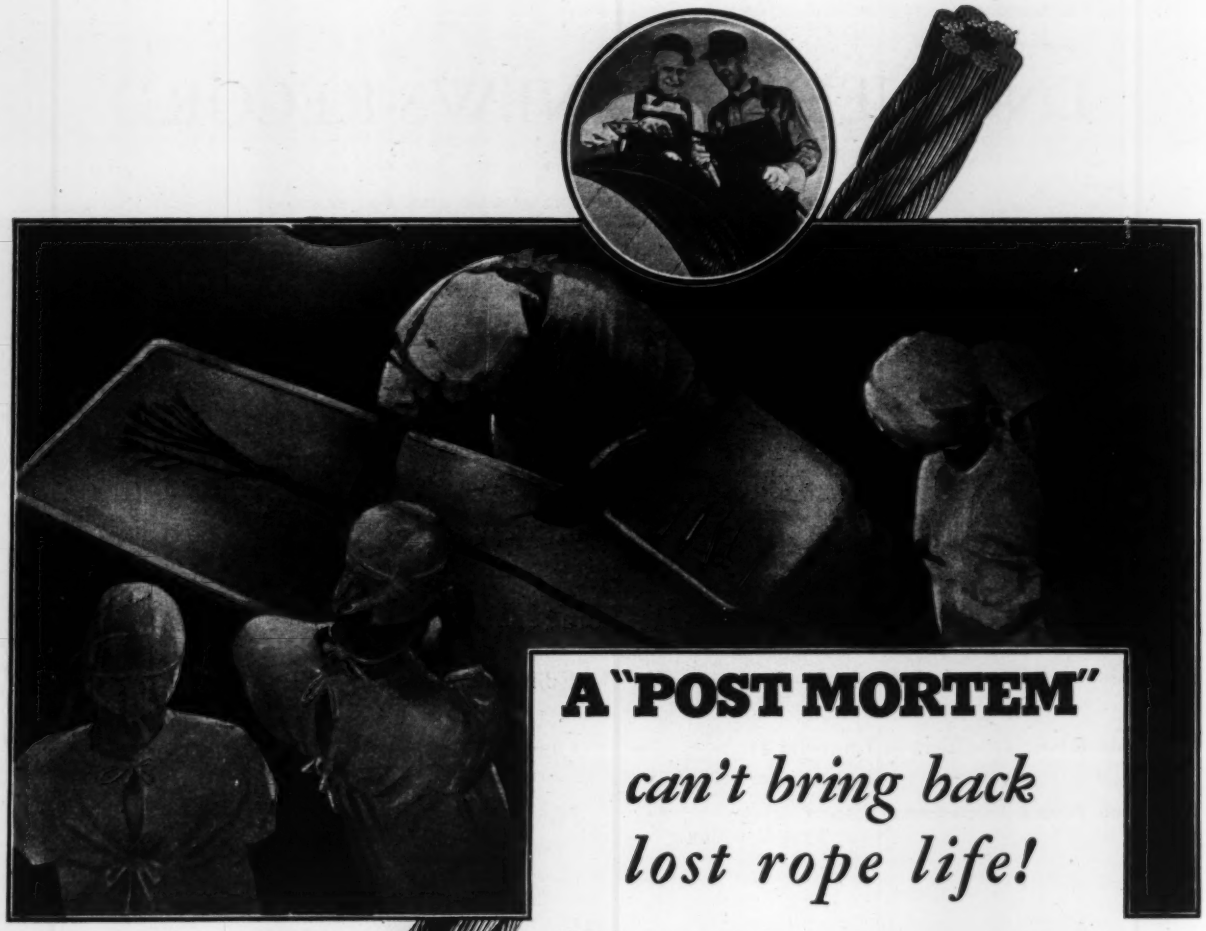
PROF. HARDY CROSS, able and well-known structural engineer and teacher, does the profession an outstanding service in a searching analysis of the present limitations and proper applications of structural analysis. In this week's issue and again next week he writes with his characteristic clarity on a subject that is showing so much new vitality as to engender a feeling of confusion in the traditionally conservative minds of engineers.

REMOVING 60,000 tons of silt per day from the waters of the Colorado River is the task which the Imperial Irrigation District is undertaking with an unprecedented installation of equipment at Imperial Dam. The installation and its design are presented in this issue.

THE NEW FEDERAL HOUSING PROGRAM of PWA is presented in tabular form.

Coming Articles:

PUZZOLANAS are coming back into the concrete-making art. Either as blending agents in cements or as admixtures in concrete, puzzolanic materials will give engineers something new and important to think about. Next week an article will be published that will provide a substantial base upon which to begin this thinking. Written by Dr. Edw. W. Scripture, Jr., director, Master Builders' Research Laboratories, it will present an authoritative analysis of the possibilities of puzzolanas in mortars and concretes.



A "POST MORTEM" *can't bring back lost rope life!*

HOLD an investigation before the rope is used —and you'll never need to hold "post mortems" afterwards. Or—better still—save yourself the grief of trying to be a "rope doctor" by putting the responsibility for wire rope performance at the source where it belongs. The world's most experienced source for dependable wire rope—and incidentally the largest—is the American Steel & Wire Company—makers of Tiger Brand Wire Rope —the rope that outperforms and outsells all other brands. Use this source—and you'll be certain of getting the proper rope for the job it has to perform.

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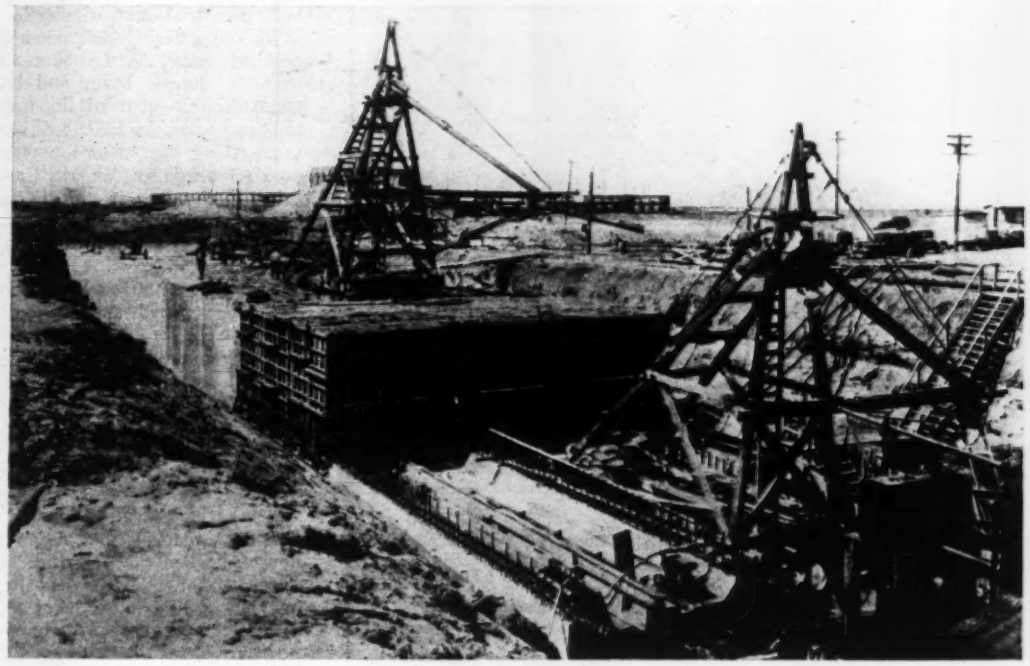


FIG. 1—CONCRETING of the drainage conduits was carried forward in two stages with concrete distribution derricks moved forward on the completed invert and on the top. Concrete was pumped to the chute hoppers at the top of the derricks.

Cahokia Creek Diversion and East St. Louis Drainage

Putting creek into wide channels and large conduits eliminates flood hazards in an intensely developed industrial area—Diesel-powered pumping station and backwater gates at levee outlet will replace old backwater gates—All concrete pumped from central plants

By H. Shifrin
Consulting Engineer, St. Louis, Mo.

PREVENTION of floods in the American Bottoms of East St. Louis, Ill., is being accomplished by putting the lower 4-mile section of the meandering Cahokia Creek into a 2-mile diversion and outfall, composed in part of open channel and in part of triple-box conduit having a capacity of 2,000 sec.-ft. A diesel-driven pumping station of 1,070 sec.-ft. capacity will be located at the outlet through the levee skirting the Mississippi River, for use during times of high water. These units are part of the comprehensive flood-control plan originally developed by Col. John A. Ockerson 26 years ago and subsequently revised and adopted by the East Side Levee and Sanitary District following the flood of 1903.

The entire plan, as shown in Fig. 2, comprised a diversion channel from the bluffs to the river levee on the upstream side of the area, a riverfront levee with backwater gates, a canal skirting the bluffs, and an interior drainage system provided with floodgates and pumping stations. It is a portion of this latter part of the project that was made possible through PWA financing on which work began last January. Various sections of the project have been described previously. (*Engineering News*, Feb. 2, 1911, p. 132; Aug. 28, 1913, p. 432; Feb. 5, 1914, p. 300. *Engineering News-Record*, Oct. 30, 1919, p. 814; July 14, 1921, p. 56 and Oct. 20, 1921, p. 668.)

The American Bottoms is a flat area of 99 sq.mi., 5 or 6 miles wide between the river and the bluffs and nearly 20 miles long from the existing Cahokia diversion channel on the north or upstream end to the Prairie du Pont Channel at the lower end. The elevation ranges from 20 to 37 ft. on the St. Louis gage. Flood stage is 30. Some 340 sq.mi. on the bluffs to the east drained originally through the bottoms, which area has developed with large railroad yards, industries and warehousing facilities that serve St. Louis. The Bottoms are divided into north and south halves by high ground along which the Baltimore & Ohio R.R. tracks are laid.

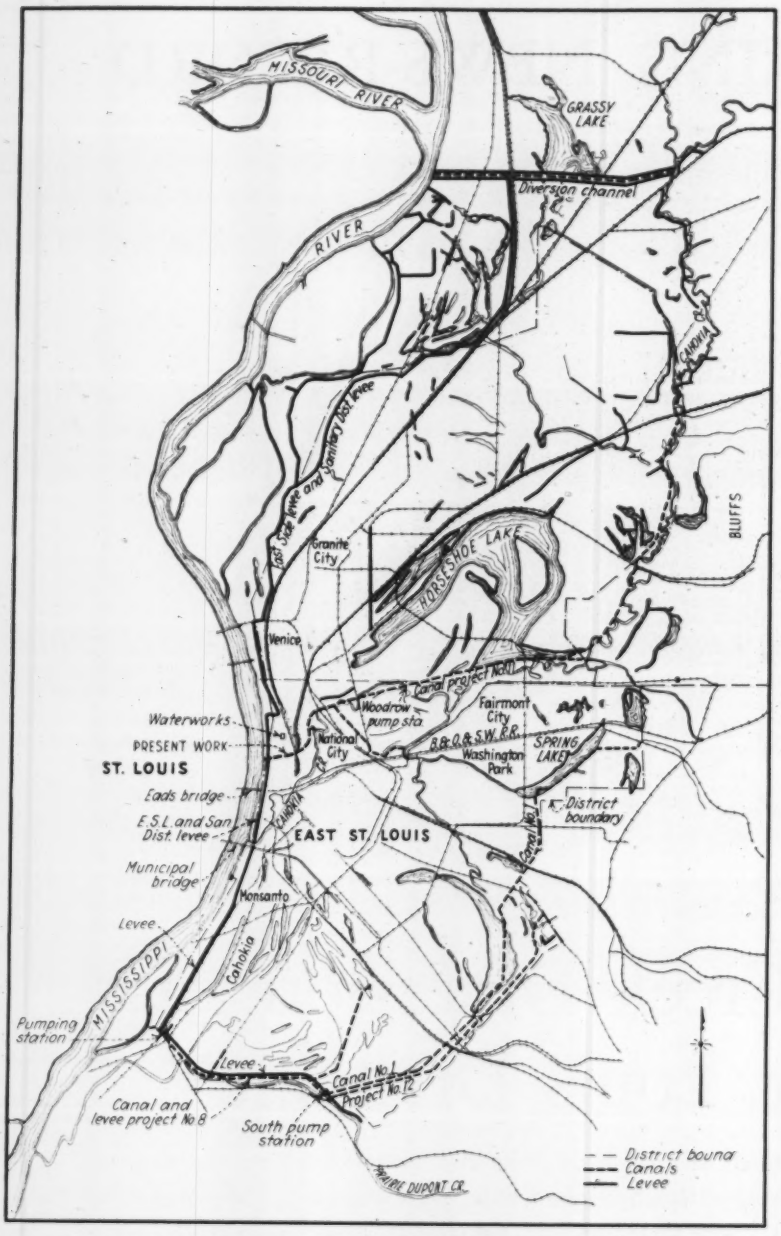


FIG. 2—A COMPREHENSIVE FLOOD-CONTROL PLAN for East St. Louis was laid out 26 years ago. The principal elements here shown are from a map published in 1919 (*ENR*, Oct. 30, p. 815). The present work is in the industrial area near the mouth of Cahokia Creek.

Through the north half Cahokia Creek flows west and south in a winding course, draining a hillside area of 310 sq.mi. and 67 sq.mi. of bottomland. Prairie du Pont Creek drains the southern portion of the bottomland along the southern limits of the district. The 1903 flood reached 38 ft. on the St. Louis gage and caused so much damage that the Sanitary District was formed in 1909.

The northern diversion channel was the first project constructed by the district. This was followed by the construction of levees to El. 45 along the river, from the embankment along the north diversion channel to the south limits, supplemented by a south levee to the bluffs. Pending the construction of pumping stations and an adequate system of interior channels, there were installed, as a temporary measure, backwater gates along the levees at the creek openings emptying into the Mississippi River, with the requirement that these backwater gates would be closed when the river reached a 20-ft. stage.

As funds became available through taxation or by sale of bonds, additional drainage projects and several pumping stations were constructed in the portions of the district where the needs were most urgent. For the lower Cahokia Creek development, it was early suggested that a diversion channel be constructed with a pumping station at the levee, this project to enable the abandonment of the present Cahokia Creek, which has been an eyesore and a menace to public health for a number of years. During dry weather the flow through this creek is practically nothing but industrial and domestic sewage. With the gates closed, when the river reached stage 20, Cahokia Creek became a storage basin and backed up when rainfall occurred, flooding the low lands along its banks and filling the low areas along the eastern portion of the area tributary to Cahokia Creek. Fortunately, the damage resulting from lack of drainage was minimized by the fact that a number of lakes existed along this eastern lowland portion, which served as storage basins until such time as the gates could be opened and an outlet made available.

The remaining drainage area tributary to Cahokia Creek, after the northern diversion channel was built, consisted of 50 sq.mi. of hillside areas and 70 sq.mi. of bottomlands. Runoff from the hillside areas reaches Cahokia Creek through four natural hillside creeks which carry a large amount of silt until the flow reaches the flatlands of the bottoms, when the velocities are so reduced that the silt is deposited in the low places in natural lakes and in the waterways through which the runoff flows. Of the bottom lands 28 sq.mi. are tributary to an improved portion of Cahokia Creek, which has been straightened and widened but which now needs to be redredged, due to silting. Approximately 32 sq.mi. of the bottomlands drain directly to Horseshoe Lake, which is a large natural storage reservoir located in the central portion of the bottoms and which empties, when grades permit, into the natural channel of Cahokia Creek. Below Horseshoe Lake the creek drains an area of 7 sq.mi. of urban area situated in East St. Louis and in Washington Park and Fairmont City eastwardly from East St. Louis, from which areas domestic sewage reaches the creek. Fig. 3 shows the present location of the creek, which empties into the Mississippi River in the vicinity of the St. Louis Municipal Bridge.

A number of engineering reports have been prepared during the past 25 years covering the diversion and pumping facilities necessary for the elimination of the present Cahokia Creek and the substitution of a new channel or conduit to provide adequate drainage at all times. In most instances the plans recommended either a closed conduit or part conduit and part channel for intercepting the flow north and east of National City, where the East St. Louis National Stock Yards are located, and carrying it in a direct line to the Mississippi River, with backwater flood gates and a pumping station at the levee to operate when the river stage reaches

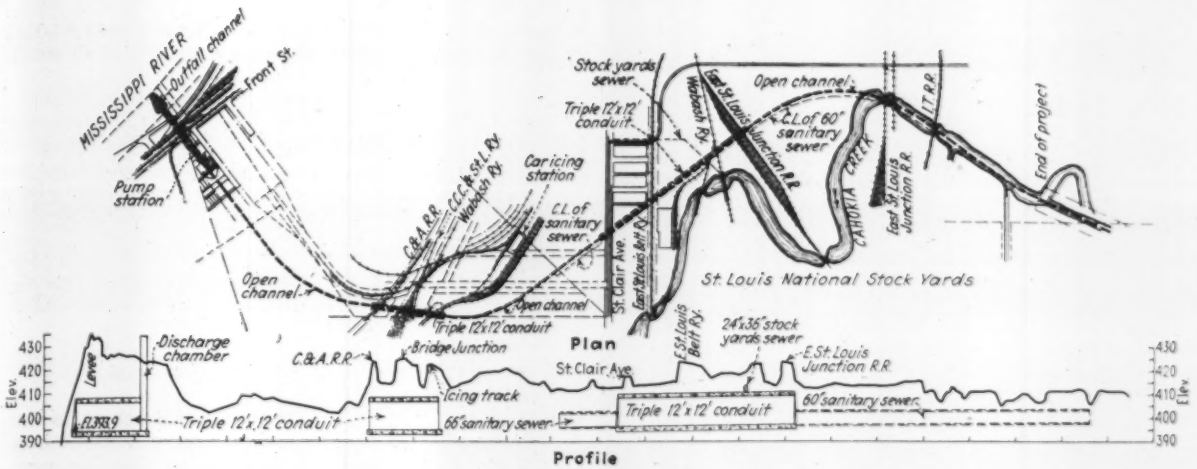


FIG. 3—PLAN AND PROFILE of the diversion channel. For a considerable part of its length it is located in a triple 12x12-ft. box conduit.

a point above 20 on the St. Louis gage.

With the establishment of the Public Works Administration, W. W. Horner and the writer were retained as consulting engineers to check the plans prepared by the engineering organizations of the district, and to prepare a loan application. The preliminary plans, which had been prepared under the direction of E. F. Harper, chief engineer of the district were checked for hydraulic capacity of the open channel and conduit sections proposed. The runoff from the tributary areas, for rainfall frequencies of five years, fifteen years and for the unusual frequency of rainfall which occurred in the St. Louis area on Aug. 20, 1915 (probably frequency of 50 years), was computed and hydraulic grades plotted for these runoffs, for the conduit and open channel sections, with both a free outlet and with the gates closed and pumping necessary at the mouth of the proposed channel.

The present plans provide for a capacity of 2,000 sec.-ft. and pumping equipment for a capacity slightly in excess of 1,000 sec.-ft., which, as the studies had indicated, would prove satisfactory provided Horseshoe Lake could be maintained as a storage basin. Ultimately, as the area is further developed and improvements are made in the district, doubling the capacity of the pumping station will probably be justified, so that a runoff of 2,000 sec.-ft. can be taken care of against all stages of the Mississippi River.

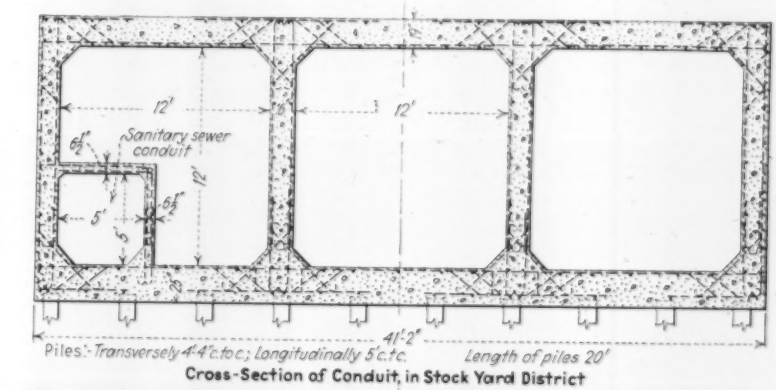
Construction under way

Construction operations under two contracts are now under way, one for the pumping structure, conduits and open channel sections ($1,993,731; G. L. Tarlton, St. Louis), and one for the mechanical equipment in the pumping station structure ($287,466; Fairbanks-Morse & Co.).

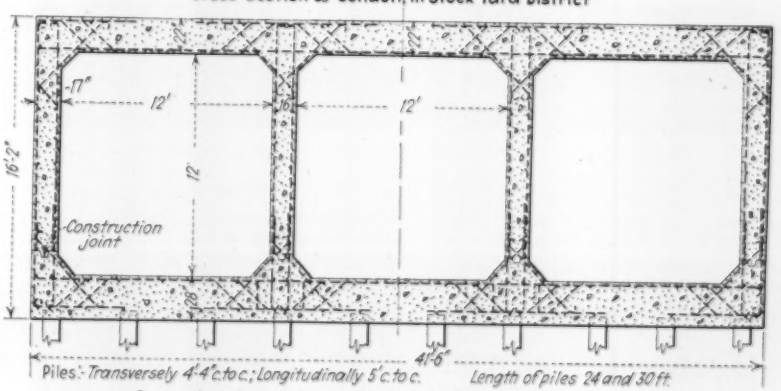
Alignment and profile of the present project are shown on Fig. 3. This construction involves two miles of open channel and conduits, as compared to the four-mile present channel of Cahokia Creek. On this length of four miles there are more than twenty railroad trestles, each of which has resulted in a contraction of waterway and a reduction of channel capacity. Practically all of these trestles can be abandoned with the completion of the present project.

Work on contract 1 consists of constructing the open channel to a bottom width of 36 ft., with side slopes of one or two carried up to the elevation of adjacent ground. The maximum depth of water within the open channel, when carrying 2,000 sec.-ft. with a free outlet, will be 10.3 ft. With the gates

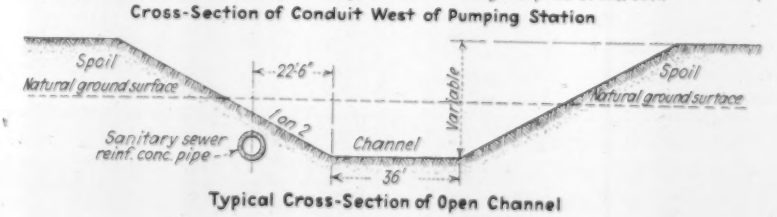
FIG. 4—TRIPLE-BOX CONDUITS and open channels designed to carry 2,000 sec.ft.



Cross-Section of Conduit in Stock Yard District



Cross-Section of Conduit West of Pumping Station



Typical Cross-Section of Open Channel

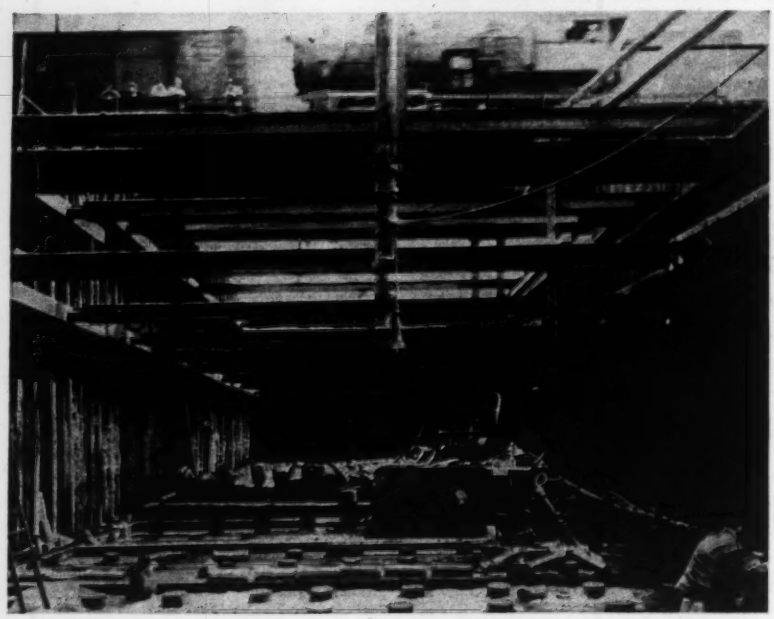


FIG. 5—TIGHTLY SHEATHED TRENCH was used next to river for the box conduits. Water was kept down with a well-point system. The piledriving unit is at the right center.

closed and the pumps operating at a capacity of 1,000 sec.-ft., the depth in the channel should not exceed 12 ft. under the most severe conditions.

The reinforced-concrete conduit sections consist of three 12x12-ft. reinforced-concrete boxes set on wood piles, as shown in Fig. 4. The base for the section through the levee, where a fine waterbearing sand is encountered, is 28 in. thick, but for the other two sections it is 25 in. thick. Side walls for the levee sections are 17 in. and for other sections 15 in.

To carry the sanitary flow in a confined, relatively small area, there is being constructed along one corner of part of the conduit a reinforced-concrete box section 5 ft. square. Above and below the conduit section in the stockyards region 5- and 5½-ft. reinforced-concrete circular sewers are being laid within the slopes south of the open channel for carrying the ordinary dry-weather flow, which consists of industrial waste and domestic sewage. Under the present project this sewer empties into the open channel below the stockyard area, but an application for additional money to continue it to the pumping station is now before the PWA.

Pumping station

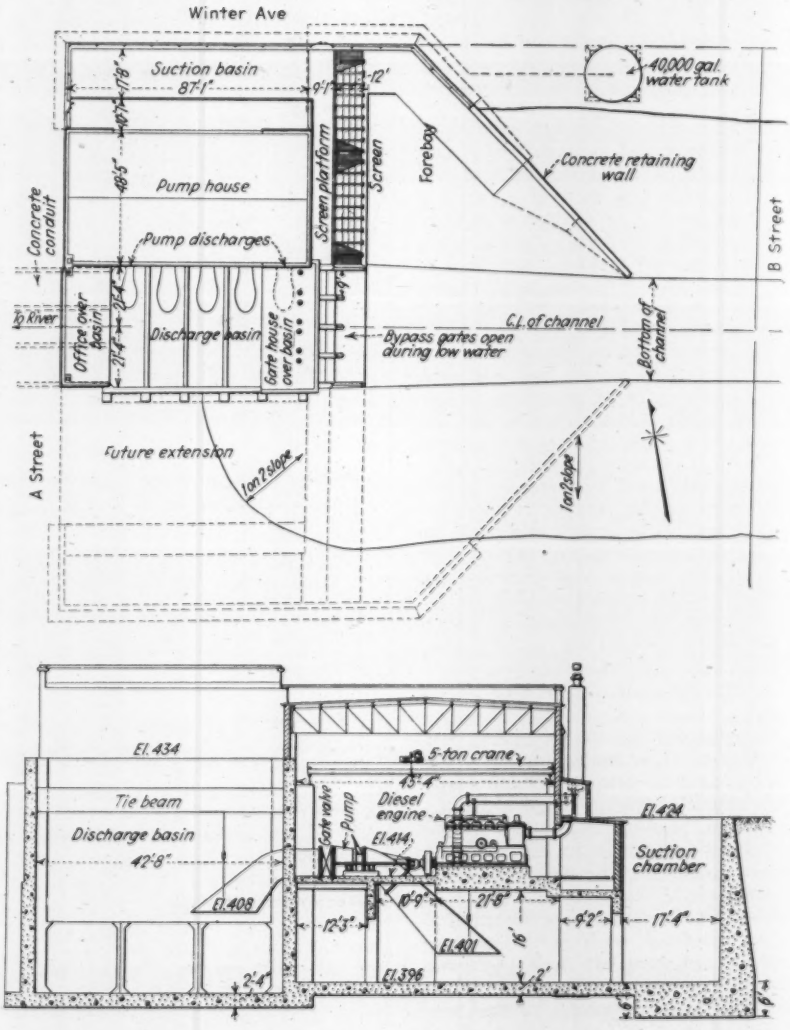
The pumping station structure is located 750 ft. from the river, and is to house four 60-in. propeller pumps having a capacity of 250 sec.-ft. when operating against a static head of 13 ft. Each is driven by a 525-hp. diesel engine. In addition, there is being provided a 42-in. propeller pump to be driven by a 225-hp. diesel engine. This pump will have a capacity of 70 sec.-ft. against a static head of 13 ft.

The necessary generating units and accessories, including the installation of the main pumps and engines, backwater gates and operating mechanism for the backwater gates, will be installed in the pumping station structure by the machinery and equipment contractor. The four 9x12-ft. backwater gates are to be operated with electric motor controls designed to close the gates when a 20-ft. stage is reached.

Channel construction

The channel construction involves crossing under 40 railroad tracks in the heart of the East St. Louis industrial switching district, making necessary the extensive use of temporary bridges for carrying railroad tracks across the proposed work. Excavation of the 500,000

FIG. 6—THE PUMPING STATION has four diesel-powered centrifugal units with a capacity of 250 sec.-ft. each and one of 70-sec.-ft. capacity.



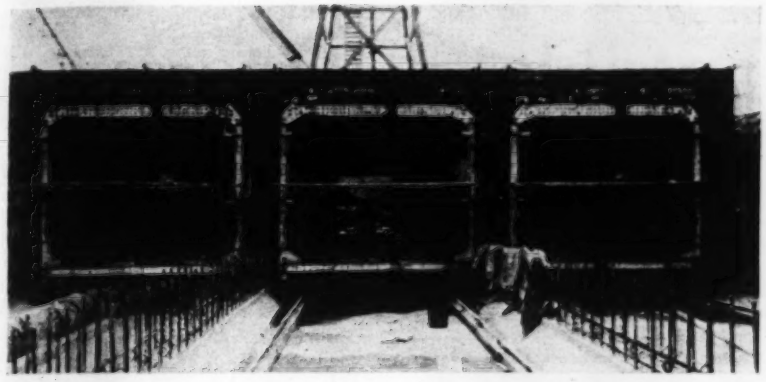


FIG. 7—STEEL FORMS used for the insides of the conduits were advanced on rails laid on the invert floor.

yd. involved in the contract is being carried out with draglines equipped with 1½-yd. and 2½-yd. buckets.

From the river to the discharge basin adjoining the pumping station, the triple box section, slightly over 700 ft. in length, is set on wood piling. In this area the construction was carried out within a tightly steel-braced, steel-sheathed trench. The soil encountered consists of a very fine waterbearing sand, which permits the groundwater to rise with the rise in river stages. In order to obtain a satisfactory subgrade for the placing of concrete, well points were installed longitudinally along the sides of the excavation and transversely at sufficiently frequent intervals to prevent the accumulation of groundwater and to check a flow through the trench. Fig. 5 is a view of the lower end of the conduit adjacent to the river, showing the steel sheetpiling and braces and the wood piling cut off to finished grade for foundation.

Construction of the project was carried out in three distinctly separate but simultaneous operations. For the construction of the closed conduit outlet section below the pumping station and for the pumping station proper, there was set up a 2-yd. concrete mixer with the necessary weighing batchers and hoppers to insure satisfactory control and mix of concrete, in accordance with the strength specifications, which call for a 3,500-lb. minimum compressive strength of concrete, based on 28-day job-control cylinders. The plant was located along the railroad tracks, with the conveyor from the discharge skip carrying the concrete to a hopper set up above a concrete pump that forced the concrete through a 7-in. pipe to the point of placement. This method of handling concrete proved efficient in this location, as it eliminated interference to continuous delivery, which would have occurred if concrete had been delivered in trucks crossing railroad yards. No difficulty arose in the placing of the concrete in this manner and in obtaining a satisfactory consistency, with the compressive strength of the concrete generally in excess of that specified.

From this Front St. plant a line also was laid to the pumping station site, and all concrete placed in the pumping station structure was mixed and pumped from this location.

At the same time that this work was going on along the western limits of the project, work was carried out on the 1,900-ft. triple box eastern conduit also set on piling, beginning immediately west of St. Clair Ave., which is in the vicinity of the National Stock Yards. For this work, an existing central mix concrete plant, which contains a 2-yd stationary mixer with the necessary weighing batchers, hoppers and water tanks, was utilized. It is located on St. Clair Ave. within a relatively short distance of the site of the work. Concrete was hauled in trucks from the mixer and discharged into a hopper set above the concrete pump. Here, also, concrete was pumped through a 7-in. pipe to a hopper set on a discharging derrick, from which chutes distribute it to the forms. Fig. 1 shows the progressive construction of the concrete conduit in this location.

The contracting agency for the work is the East Side Levee and Sanitary District, a municipality of St. Clair and Madison Counties, which is governed by a board of five trustees elected every four years and which is now headed by S. H. Kernan as president. The work on this project is being carried out under the immediate supervision of E. F. Harper, chief engineer of the district, and W. E. Putnam, resident engineer in charge of the construction. The Public Works Administration maintains an engineering organization under the supervision of G. L. Rounds. For G. L. Tarlton, the contractor, J. C. Hail is general manager and J. J. Gilmore superintendent.

Flood Control Zones Established Under Washington Law

PARTICULARLY heavy floods during the past two years impressed upon the state of Washington the need of action that would be of material benefit in reducing the hazards of flood conditions. In the early part of this year a law was enacted providing for the creation of flood control districts under the supervision of the state director of hydraulics. To date, four zones have been established, and several more are in the process of being formed.

C. J. Bartholet, supervisor of hydraulics for the state of Washington, points out in a recent communication: "One outstanding conclusion reached was that much of the damage (from floods) was caused by works of man: inadequate bridge and culvert openings, encroachment upon flood plains and upon normal channels by dikes and embankments, structures and works of various kinds placed in the stream channels for the protection of specific property without regard to its effect upon the general regimen of the stream, etc.

"It was found that there was no stability provision for public regulation of works which might adversely affect flood conditions, and that, except on navigable waters, anyone might do as he pleased on his own property subject only to a suit for damages where provable."

The Flood Zoning Act declares that "The alleviation of recurring flood damages to public and private property, to the public health and safety, and to the development of the natural resources of the state, is declared to be a matter of public concern, and as an aid in effecting such alleviation the state of Washington, in the exercise of its sovereign and police powers, hereby assumes full regulatory control over the navigable and non-navigable waters flowing or lying within the borders of the state, subject always to the federal control of navigation . . .

"State regulatory control shall be exercised through regulatory orders, the designation of flood control zones and the issuance of permits . . . and shall be exercised over the planning, construction, operation and maintenance of any works, structures and improvements, public or private, which might, if improperly planned, constructed, operated or maintained, adversely influence the regimen of a stream or body of water or might adversely affect life, health and property against damage by floodwater."

All streams in the state of Washington subject to damaging floods will ultimately be zoned. Generally speaking, a zone includes the entire flood plain of a stream from its mouth to a point near its source.

Contracts Impossible to Perform—I

A review of the law as determined by legal opinion and court decisions in many cases of past and recent legislation

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WHEN is a construction contract impossible of performance? The records of litigation over the answer to this question include many cases and occupy many pages of judicial opinion. It can be stated that in law impossibility embraces a number of meanings not familiar to the engineering constructor but meanings with which he should have some acquaintance if he is to assume contractual responsibilities with intelligence. It is the purpose of this and a succeeding article to make this acquaintance possible. The warning is necessary, however, that no such article can be a substitute for legal advice in any specific case; the most that it can do is to indicate where rights and responsibilities lie in general, so that obligations may not be unwittingly approached.

What is a contract?

Most engineers and contractors have a general notion of what a contract is, but the law is very specific in its definition. According to the Restatement of the Law of Contracts of the American Law Institute,

> *A contract is a promise or a set of promises for the breach of which the law gives a remedy or the performance of which the law in some way recognizes as a duty.*

Thus, a contract is distinguished from an agreement which is broader in scope and includes transactions where legal consequences are or are not contemplated or produced. For example: If *A* should promise to pay *B* $500 on a certain day without any return promise or performance by *B*, *A's* promise, unsupported by a consideration, would not constitute a contract and therefore would create no duty of performance by him.

We are not concerned here with the elements that contribute to the making of a contract, but, on the contrary, with the means by which contractual duties are prevented from arising or are discharged after their creation. Of this character is impossibility of performance.

Impossibility is defined in the Restatement of the Law of Contracts as follows:

> *Impossibility means not only strict impossibility, but impracticability because of extreme and unreasonable difficulty, expense, injury or loss involved.*

In the case of Mineral Park Land Co. *vs.* Howard et al. (156 Pacific 458), decided by the Supreme Court of California in 1916, it appears that the parties made a contract whereby the defendants agreed to take from the plaintiff's land 114,000 cu.yd. of gravel and to pay the plaintiff therefor a certain sum per cubic yard. The plaintiff's land contained the required amount of gravel, but only 50,131 cu.yd. were above water, and this the defendant took.

The court found that no greater quantity could have been taken "by ordinary means," that it could have been excavated at great expense by a steam-dredger, but that the earth and gravel so taken could not have been used without first having been dried at great expense and delay. It also found that the balance of gravel could have been taken at an expense of ten or twelve times as much as the usual cost per yard. The court released the defendants from their duty to perform on the ground that the contract was impossible to perform. It held that,

> A thing is impossible in legal contemplation when it is not practicable; and a thing is impracticable when it can only be done at an excessive and unreasonable cost. (Beach on Contracts 216). We do not mean to intimate that the defendants could excuse themselves by showing the existence of conditions which would make the performance of their obligation more expensive than they had anticipated or which would entail a loss upon them. But, where the difference in cost is so great as here and has the effect as found of making performance impracticable, the situation is not different from that of a total absence of earth and gravel.

Inability is not impossibility

In the discussion of our subject we must distinguish at the very outset between impossibility due to the nature of the project undertaken in the contract and impossibility due solely and wholly to the inability of one of the parties to perform his promise.

In the latter case, except in contracts that require the personal services of one of the parties, which we shall later discuss in detail, impossibility is of no avail as an excuse for failure to perform. For example, suppose *A*, a contractor, promises to build a road in accordance with certain plans and specification. He has no money and cannot borrow any for the purpose of supplying the necessary materials and labor. It is impossible for him to perform. But impossibility in this case is due solely and wholly to his lack of the necessary funds. It is not due to the nature of the performance which he undertook. Another contractor with sufficient cash could perform the terms of this contract. Impossibility is here no legal excuse for *A's* failure to build the road. He is, therefore, liable for breach of contract.

Our future discussion of this subject concerns itself only with impossibility due to the nature of the project. Impossibility may exist at the time the parties attempt to make their contract or may arise subsequent to its formation.

Existing impossibility prevents contract

In the first case, it prevents the formation of a contract. Neither party is liable for failure to perform. For example, suppose *A*, a general contractor, makes a contract with *B* to construct a concrete dam in accordance with plans and specifications prepared by engineers employed by *B*. The plans are defective, and as a result the structure collapses after a portion is erected. Here because of the defective plans performance is impossible when the contract is made. *A* is therefore under no duty to perform.

In the case of Kinzer Construction Co. against the State of New York (125 N.Y. Supp. 46), decided in 1910 by the Court of Claims, it appeared that the claimant made a contract with the state of New York to construct 3.75 miles of the improved Champlain Canal. While the work was in progress and the claimant was excavating for one of the locks an extensive cave-in occurred. It was found that the earth was of slippery greasy clay with insufficient strength to permit construction according to the plans and specifications. The court in its opinion stated:

> Under this condition of things the case falls within that line of decisions where the contract is regarded as at an end and performance is excused because of the failure of conditions, the existence of which are necessary to the performance of the contract.

It would not have been fair of the state to insist upon the literal performance of its contract and place the loss upon the claimant for the failure to perform, nor would it have been just for the claimant to insist that the state must carry out its contract as planned or suffer the penalty of paying damages, including prospective profits for the breach of the contract. It is better to regard the contract as at an end and treat both parties as having been excused from further performance.

Impossibility must be unknown

An important requirement in this class of cases is that the party undertaking to perform neither know nor have reason to know at the time of making the promise the facts making performance impossible. If the contractor knows or has reason to know of the defective nature of the plans and nevertheless undertakes to build, he is bound to complete the structure or pay damages for breach of contract.

In the ordinary case the contractor may be presumed to have sufficient experience to charge him with knowledge of whether the plans are sufficient and whether the project is feasible, and he would not be excused on the ground that he relied on the sufficiency of defective plans that were furnished by the owner. Where, however, the work is of such a highly technical nature as to require the making of plans by expert engineers employed by the owner, the latter impliedly warrants the sufficiency of the plans. In such cases the contractor would be justified in relying on the plans and would not be held liable should the structure collapse.

Example found in sewer case

In the case of the United States against Spearing (248, U. S. 132), decided by the United States Supreme Court in 1918, it appears that Spearing contracted to build a drydock at the Brooklyn Navy Yard in accordance with plans and specifications prepared by the government. The site selected was intersected by a 6-ft. brick sewer. The plans and specifications provided for the relocation of this sewer. A large part of the new section was within the area set aside as space within which the contractor's operations were to be carried on. The new section connected at both ends within the Navy Yard, but outside the space reserved for work on the drydock it connected with a 7-ft. sewer emptying into the Wallabout Basin. About a year after this relocation a heavy downpour of rain and high tide forced the water up the sewer for a considerable distance to a depth of 2 ft. or more. Excessive pressure broke the new sewer at several places. As a result the excavation of the drydock was flooded. Upon investigation it appeared that in the 7-ft. sewer was a dam from 5 to 5½ ft. high which diverted the greater part of the water to the new 6-ft. section. Both sewers were part of the city sewerage system. But the dam was not shown on the city's plans or on the government plan. The government officials concerned with the letting of the contract for the drydock did not know of the existence of the dam. But other government officials knew that for some years prior to the making of this contract the sewers had from time to time overflowed. Spearing was not advised of this. Before entering into the contract he made a superficial examination of the premises but made no special examination of the sewer and had no information on the possibility of floods.

After the breaking of the sewer he demanded that the government assume responsibility for the damage already done and make such changes in the sewer system as would remove the danger or assume responsibility for any damage which might thereafter be occasioned by the location and design of the existing sewers. The government refused to do this, claiming that the responsibility for remedying the existing conditions rested with the contractor.

Upon the refusal of the contractor to proceed with the work under the conditions laid down by the government, the Secretary of the Navy annulled the contract and took possession of the plant and materials on the site. Later the work was completed by another contractor.

Among the general clauses in the specifications were the following:

Examination of Site—Intending bidders are expected to examine the site of the proposed drydock and inform themselves thoroughly of the actual conditions and requirements before submitting proposals.

Checking Plans and Dimensions; Lines and Levels—The contractor shall check all plans furnished him immediately upon their receipt and promptly notify the civil engineer in charge of any discrepancies discovered therein. . . . The contractor will be held responsible for the lines and levels of his work, and he must combine all materials properly so that the completed structure shall conform to the true intent and meaning of the plans and specifications.

Contractor's Responsibility—The contractor shall be responsible for the entire work and every part thereof until completion and final acceptance by the Chief of Bureau of Yards & Docks and for all tools appliances and property of every description used in connection therewith. . . .

The opinion of Mr. Justice Brandeis in part is as follows:

But if the contractor is bound to build according to plans and specifications prepared by the owner, the contractor will not be responsible for the consequences of defects in the plans and specifications. . . . This responsibility of the owner is not overcome by the usual clauses requiring builders to visit the site, to check the plans, and to inform themselves of the requirement of the work. . . .

But the insertion of the articles prescribing the character, dimensions and location of the sewer imported a warranty that if the specifications were complied with, the sewer would be adequate. The implied warranty is not overcome by the general clauses requiring the contractor to examine the site, to check up the plans and to assume responsibility for the work until completion and acceptance. The obligation to examine the site did not impose upon him the duty of making a diligent enquiry into the history of the locality with a view to determining at his peril whether the sewer specifically prescribed by the government would prove adequate. The duty to check plans did not impose the obligation to pass upon their adequacy to accomplish the purpose in view. And the provision concerning contractor's responsibility cannot be construed as abridging right arising under specific provisions of the contract.

The court thereupon held that the contractor was excused from further performance and granted judgment in his favor for the work performed.

Thus, we see that where performance is impossible at the time of making the promise and the promisor did not know or have reason to know of the facts which make performance impossible, his promise is not binding.

Impossibility arising after contract

Now, assume that the facts which make performance impossible arise after the making of the contract. What, then, are the rights and duties of the contractor, owner and engineer? The early decisions of the courts in this country held the parties strictly to account regardless of what facts may have developed to frustrate the efforts of one of the contracting parties to perform. This was in line with judicial opinion in England at that time. So, we find that in the early case of Harmony vs. Bingham (12 N.Y. 99) the Court of Appeals of New York State held in 1854 that: "It is a well settled rule that where . . . the party by his own contract creates a duty or charge upon himself, he is bound to make it good notwithstanding any accident or delay by inevitable necessity, because he might have provided against it by contract."

About the middle of the 19th century the courts here, as well as in England, adopted a more liberal attitude. Apparently, they felt that their decisions holding the parties to the strict letter of their contract in many instances wrought great injustice upon litigants. Heretofore, although through no fault of the contractor, if conditions arose which made performance impossible, he was nevertheless charged with damages for breach of contract.

Present Law—In changing their attitude toward these cases the courts assuaged their consciences by reading into contracts certain implied covenants. Thus, we have now reached the point where the courts say that in all contracts, unless specific provision is made to the contrary, the parties impliedly covenant that the duty of the promisor to perform shall terminate under the following circumstances:

First: Where a change in domestic law or a judicial, executive or administrative order made with due authority

by a judge or other office of the United States or anyone of the United States prohibits performance.

Second: In contracts requiring of the promisor, his or another's personal services, performance of which cannot be delegated or assigned, where illness or death occurs.

Third: Where the specific thing which is essential to performance of the contract is destroyed.

Fourth: Where particular facts other than specific things, which are by the terms of a bargain or in the contemplation of both parties necessary for the performance of a promise, subsequently do not exist.

Effect of domestic law changes

With regard to the first implied covenant, it is to be noted that the change must be one of a domestic law. By domestic law is meant the constitution or a statute of the United States or of one of the United States whose law determines the validity and effect of the contract or a municipal regulation enacted with a constitutional or statutory authority of such a state (Restatement of the Law of Contracts.) If a contract, for example, is made in Pennsylvania for the delivery in Pennsylvania of certain steel to be used by the purchaser on a construction job in New York, a statute enacted in New York making the construction illegal would be a change in foreign law, not domestic law, because the law of Pennsylvania controls the validity and effect of the contract inasmuch as the contract was made and was to be performed in Pennsylvania.

In the case of Public Service Electric Co. vs. Board of Public Utility Commissioners of the City of Plainfield (93 Atlantic Reporter 707), decided by the Supreme Court of New Jersey in 1915, it appeared that in 1898 the predecessor of the plaintiff entered into a written contract with the city of Plainfield whereby the said predecessor was permitted to use the city's streets for its poles and wires, and in consideration thereof it agreed to light free of charge certain municipal buildings, offices and rooms owned by the city or occupied for city purposes. In 1911 a law was passed in New Jersey which forbade the making or giving of any undue or unreasonable preference or advantage to any corporation or locality. The plaintiff contended that this made performance of the contract of 1898 unlawful.

In upholding the contention of the plaintiff the court stated in its opinion:

> We think, however, that the Public Utilities Act in forbidding discrimination made the performance of this contract unlawful and that, therefore, the prosecutor (plaintiff) could not continue to perform the contract without being guilty of a violation of that statute. Thus, we have the case of a contract lawful when made, the performance of which subsequently became unlawful. It is perfectly well settled that the effect of this is to excuse the promisor from performance. Pollack on Contracts, 4th Edition, 406; Pomeroy on Contracts 280.

Furthermore, a judicial, executive or administrative order made with due authority by a judge or other officer of the United States or of any one of the United States preventing or prohibiting performance of the contract will discharge or postpone the duty of performance. Whether performance is discharged or merely postponed depends on the duration and nature of the delay. If it is merely of short duration, a postponement will result. If the delay is serious and will involve substantial loss on the part of the promisor, should he be compelled to perform, he will be excused from performance.

In the case of Colonial Trust Co. vs. Bodek et al. (155 Atlantic Reporter 799), decided by the Court of Chancery of New Jersey in August, 1931, it appeared that the seller of certain premises in North Wildwood in which a municipal sewerage plant was in operation agreed among other things to "install sewers" within a certain period. Upon application of the State Board of Health an injunction was obtained against the city of North Wildwood restraining it from permitting additional connections to be made to said sewerage plant until a certain disposal plant was erected. The court held that the performance of the contract to "install sewers" was suspended until the removal of the injunction.

Where, however, a change in foreign law makes performance impossible, the change is regarded as one of fact, not law, and the promisor is answerable for damages for his failure to perform.

Change in foreign law does not discharge duty to perform

In the case of Tweedie Trading Co. vs. James P. McDonald Co. (114 Federal Rep. 985), decided by the United States District Court for the Southern District of New York in 1902, it appeared that the plaintiff and the defendant entered into a contract in the United States by which the plaintiff agreed to make four trips with its steamship from Barbados to Colon to transport laborers for the defendant. The latter contracted to pay a certain sum for each trip. The contract when made was legal and valid, where made and as the place of performance. After two trips, however, a regulation of the Colonial Government of Barbados was promulgated, forbidding the future embarkation of laborers. For this reason the defendant was unable to furnish any more laborers for transportation. The plantiff sued to recover the hire of the ship for the remaining two voyages. The court in granting judgment in favor of the plaintiff held: "Prevention by the law of a foreign country is not usually deemed an excuse when the act which was contemplated by the contract was valid in view of the law of the place where it was made."

Of late, there has been a tendency on the part of our courts to lean toward the treatment of a change in foreign law on the same basis as a change in domestic law (Sokoloff vs. National City Bank 239 N.Y. 158).

Large Area Mapped in Florida by Unemployed Engineers

UNEMPLOYED engineers in Florida, where only 8 per cent of the state area had been topographically mapped prior to 1934, are completing the second year of a program of control surveying and mapping, under the supervision of the U. S. Coast and Geodetic Survey.

B. R. Van Leer, engineering dean of the University of Florida and state director of the project, used 250 persons during the first year of work, but a reduction in appropriation since that time has cut the personnel to less than 35 men, and it is thought likely that the project will soon have to be abandoned.

The work accomplished to date includes 2,761 miles of traverse lines of second order (accuracy, 1 to 10,000), along which permanent monuments have been set every two miles, and 728 miles of third-order traverse with monuments at intervals of three miles. In addition, 2,544 miles of level lines have been monumented and run, and an area of 275 square miles has been topographically mapped by plane table.

A complete compilation map of the proposed Everglades National Park in southwest Florida was also made for the use of state and federal agencies that were interested in this development in connection with future work.

As a direct result of this project, the U. S. Coast and Geodetic Survey has computed the plane coordinates of all the new monuments so that surveyors can tie in and check local surveys through the control lines. The U. S. Geological Survey is also planning to use these lines in the preparation of aerial photographs for the planimetric mapping of 9000 square miles.

Kansas Road Damage in June Floods Exceeded One Million Dollars

Engineers report that $1,301,700 will be required to restore damaged bridges and roads in Republican and Kaw River Valleys

FIG. 1—MANHATTAN, KANS. at the height of the June flood in the Kaw River. The entrance of U. S. 40 from the east is just beyond the two-span Union Pacific R.R. bridge in the right foreground.

FOLLOWING an inspection of damage caused to Kansas highways and bridges by one of the most extraordinary floods in the history of the state, R. B. Wills, construction engineer for the state highway department, and B. F. Taylor, senior highway engineer of the U. S. Bureau of Public Roads, estimate the approximate cost of restoration of damaged bridges and roads to federal aid standards at $1,301,700 in the Republican and Kaw River areas.

The flood which caused the damage resulted from extremely heavy rains in Colorado, supplemented by other rains in Nebraska along the course of the Republican River, reaching a maximum flood discharge at Bloomington, Nebraska, which is estimated at 285,000 sec. ft. by state drainage engineers and Army engineers. (ENR, June 6 and 13 pp. 821 and 859.) The Republican, rising in Colorado crosses the northwest corner of Kansas, enters Nebraska where it parallels the southern state line for about one hundred miles and then turns south into Kansas joining the Smoky Hill River at Junction City to form the Kaw River which runs easterly across the state to join the Missouri River at Kansas City.

In addition to the loss sustained by the state highway department, practically every county and township bridge spanning the Republican River was washed out. Some of the older bridges that were not lost remained in place only because the river left its channel and the bridge site during the flood. All bridges of considerable size and modern construction remained in place even though they were in the swiftest current, but approach fills and smaller structures were washed out in most cases. Since the Kansas counties and townships operate under a cash basis law, they must actually raise the necessary funds before these washed-out structures can be rebuilt. As a consequence state projects are being rushed to completion in order to handle traffic for local communities until such time as the smaller bridges can be replaced.

State highway bridge damage was unusually severe and in their report Messrs. Wills and Taylor outlined this damage in detail. Some half dozen of the worst cases are presented below.

Highway 36 crossed the Republican River west of St. Francis by means of four 35-ft. reinforced concrete deck girder spans, built in 1924. U-Type abutments and concrete pedestal type piers founded on rock were used. This structure was completely destroyed, nothing being left at the bridge location to indicate that any structure ever existed there. Records indicate that the water was 10.7 ft. higher on the west bank than on the east bank, due possibly to the general directional force of the water which came down the valley in a virtual wall. As a result the water cut 175 ft. back of where the west abutment of the river bridge formerly stood, giving a channel at this point 800 ft. wide. Estimated flow was considerably in excess of 100,000 sec.ft., reaching 150,000 sec.ft. at the state line to the north. The river through this section of the state has a fall of about 23 ft. per mile, giving an excessively high and destructive flood condition. It is estimated that it will cost about $92,000 to build 800 ft. of new river bridge.

On Highway 36 west of Scandia the river was spanned with three through steel trusses each of 135 ft. span. The bridge carried a wooden floor. The two east spans and an approach span were completely washed out. (Fig. 3.) The east abutment was completely wrecked. The west span withstood the flood.

The flood stage at Scandia is 10.1. The highest previous high water was in 1915 when the gage read 14.2. The crest of the June, 1935, flood was 17.7 with an estimated flood discharge of 225,000 sec.ft. The estimated cost of a new high level bridge and viaduct approach, 1,510 ft. in length, is $180,000. Extensive river control provision will have to be made about a mile up stream where the river left its channel and swept down across the flood plain, all but cutting a new channel about a mile west of the present state highway structure.

On Highway 81 north of Concordia traffic was being carried over an old steel structure containing two 79-ft. low truss spans and three 139-ft. high truss spans, pending the completion of approaches to a new 755-ft. bridge that had just been finished on relocation one-half mile east. The two north spans of the old bridge, one of 79 and one of 139 ft. were washed away. The new bridge,

FIG. 2—THE KAW RIVER WATERSHED occupies the north half of the state of Kansas. Rains along the Republican contributed most of the flood waters.

FIG. 3—NEAR SCANDIA two 135-ft. truss spans washed out in a 225,000-sec.-ft. discharge of the Republican River, with the stage 3.5 ft. above the previous record.

FIG. 4—NORTH OF CONCORDIA a 79-ft. and a 139-ft. span formerly bridged this opening. A half-mile downstream, the channel shifted from under a new bridge being constructed.

which was not damaged, will be extended 285 ft. on the south end before it is placed in service. The river which formerly flowed near the center of this bridge cut a new channel under the south end and for a distance of about 200 ft. south of the south end.

Flood stage at this location is 8 ft. The highest records of flood prior to 1935 gave a gage of 15 ft. in 1903 and 15 ft. in 1915. The gage in 1935 showed 16.3 ft. The engineers estimate that the extension of the new bridge will cost $40,000, that cutting a new channel east of the new bridge will cost $25,000 and that jetties for river control at the bridge site will cost $20,000, or a total of $85,000 for repairing the flood damage.

On Highway 40-N west of Clay Center, the Republican River was originally spanned with three 100-ft. through trusses. Early in 1935 a contract was let for a new bridge at this location. The new bridge being built is a continuous truss group of two 128-ft. spans and a 160-ft. span flanked with two 90-ft. simple spans. At the time of the flood the old structure, located directly upstream from the new bridge, was being used as a detour structure. The sub-structure of the new bridge was complete and all of the steel had been erected with the exception of the west approach span. The old bridge was washed out completely, while no damage at all was done to the new bridge. A considerable amount of the old approach fill however was taken out. High water elevation is at El. 237 while the flood crest reached El. 242.5. The discharge was estimated at 190,000 sec.ft. The new bridge is to be extended 227 ft. to the west to joint an existing 100-ft. overflow structure, at an estimated cost of $28,000.

An expensive bridge extension and approach fill replacements, as well as river control measures are also required at a new state highway crossing of the same stream just south of Clay Center.

On Highway 77 near Junction City, the Republican River was spanned by an old structure of two through trusses of 98 ft. span and two pony trusses of 98 ft. span, set on masonry abutments, two masonry piers and one tubular pier. The masonry pier located in the center of the stream settled from 8 to 10 in., slipped downstream about 18 in. and continued to settle at an alarming rate until temporary supports were provided for the trusses, and the pier was removed. This caused considerable damage to the floor system and the trusses of the bridge. A new bridge is to be built at a cost of $100,000 on a relocation about one mile to the west. The river gage at this point showed a crest of 18.3 ft. Previously known high water was in the flood of 1903 when the gage read 16.7 ft.

Near the south city limits of Manhattan, highways Nos. 13 and 29 cross the Kaw River on an old through pin-connected truss structure consisting of one 67-ft. span, three 128-ft. spans and one 88-ft. span. The two east through trusses were completely washed out along with the pier common to these spans when drift was released by the wash-out of two steel spans of the Rock Island Railroad bridge about 500 ft. upstream. Flood stage at this point was 17 ft. and the water in the 1935 flood reached a stage of 28 ft., about 1½ ft. lower than the 1903 flood crest. The estimated maximum discharge was 180,000 sec.ft.

A new 2,000-ft. highway structure planned for this location and estimated to cost $325,000, will span the river with continuous deck truss spans flanked by rather long viaduct approaches over the Union Pacific Railroad on the west bank and the Rock Island on the east.

Scattered flood damage of serious proportions occurred at the same time over the south central portion of the state.

Fatigue Properties of Heat-Treated Suspension Bridge Wire

FOLLOWING the removal of the heat-treated wire from the Mount Hope suspension bridge in Rhode Island and the Ambassador suspension bridge in Detroit, samples of the wire were taken to the Bureau of Standards and during the past several years have been subjected to numerous metallurgical and physical tests, to determine, if possible, the cause of the failures. The latest investigations relate to the fatigue properties of the wire. Special apparatus was developed to permit testing the wire itself instead of using standard polished and machined specimens, so as to get a measure of the effect of the surface imperfections. The wire tested was a galvanized oil-quenched and tempered steel wire, 0.192-in. nominal diameter. The fatigue limit, as shown by the tests, was 50,000 lb. per sq. in. The endurance ratio (fatigue limit to ultimate tensile strength) was 22 per cent. Specimens of the same material with the zinc coating removed had a fatigue limit of 60,000 lb. per sq. in. and an endurance ratio of 27 per cent. The report of the test, January, 1935, *Journal of Research* (National Bureau of Standards), points out that these fatigue limits are unusually low for a material with an ultimate tensile strength of 225,000 lb. per sq. in. The poor results are attributed to surface imperfections, since standard specimens machined from the same wire showed a fatigue limit of 110,000 lb. per sq. in. and an endurance ratio of 49 per cent. The heat-treated wire thus had a fatigue limit of only 45 per cent of the fatigue limit obtained on standard machined and polished specimens of the same material. Cold-drawn and mild steel wire 0.187 in. in diameter was also tested during the investigation and showed a fatigue limit of 46,000 per sq. in. and an endurance ratio of 50 per cent; comparable figures for machined and polished specimens of this cold-rolled wire were 56,000 lb. per sq. in. and 60 per cent. Thus the fatigue limit of the wire was 82 per cent of the fatigue limit of a short machined specimen of the wire. It was concluded that because of surface imperfections the fatigue limit of a structural member may be appreciably lower than that indicated by a machined and polished specimen.

Limitations and Application of Structural Analysis

[*In Two Parts*]

I—AMID the many new developments in stress analysis, especially in the field of indeterminate structures, it is desirable to distinguish between analysis for research and analysis for design—Stress analysis for design should utilize familiar concepts, and the method should be flexible

BY HARDY CROSS
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SAFE ENGINEERING means first of all correct calculation of stresses. This is true of a rigid frame or other indeterminate structure just as much as of a simple beam. Does it mean that the new systems of analysis brought out in recent years for the computation of stresses in intermediate structures are essential? Must the structural engineer use them? Do they assure safe building?

Professor Cross subjects these questions to searching scrunity by disecting the process of stress analysis into its elements. His conclusions are all in favor of simple, transparent methods as against complex and confusing procedure.

In the present first half of his study he proceeds on the view that a good method of analysis should use familiar concepts, should have a clear physical meaning at every stage and should be flexible. He holds that the quickest method is usually inferior to a slower but clearer one. He then tells what stress analysis really does and compares it with the process by which a picture puzzle is worked out. Incidentally he shows that the geometrical and the energy or least-work methods are identical.

On this foundation he will later show, in the second half of the article, that all analyses must be interpreted. The physical meaning of a stress and the extent to which chance factors may change the amount of the stress, have much to do with the safety of what the engineer builds.—EDITOR.

EVIDENCE of increasing interest in the theory of structural analysis, if needed, is given by the number of articles appearing in this field. A review of the *Transactions* of the American Society of Civil Engineers shows that about five times as many such articles were published in the third decade of the century as in the first decade. Articles are appearing today which could not have found publication twenty years ago.

This represents a condition of interesting and healthy activity, but with many it produces a feeling of confussion, of uncertainty as to standard practices, and a vague unhappiness for fear of overlooking too many important elements in the problems of design. Practical men find difficulty in digesting and evaluating the large volume of new theoretical developments, and judicious engineers decline to use theoretical formulas whose derivation they have no time to unravel.

With the traditional conservatism of engineers the writer finds himself in heartiest sympathy; a designer of engineering structures upon which the integrity of property values and the safety of human life depend has no right to accept theoretical results unless he finds for them some support in experience or in common sense.

Reasons for interest in theory

The intense expansion of structural theory in recent years is in part a result of economic conditions and in part a phase of the passion for research which has dominated all fields of effort since the beginning of the century. It has paralleled the development of new structural types, and indeed has been partly inspired by it. An excellent illustration is found in the type of structure known in this country as the rigid-frame bridge, originated by motives partly economic and largely esthetic.

There are many cases in which standard structural forms fail to satisfy functional and esthetic requirements. In the past there has been strong discouragement of the development of new types, but this attitude is passing. In some cases the rise of new structural types has produced a group of protagonists who find in them all of the virtues and none of the faults of more standard forms. It is always to be remembered that a special advantage enjoyed by a new type of construction is the lack of restricting precedent; age-old experience fails to warn, and we dare cut the margin of safety to a point which later experience may indicate to be injudicious.

There is no argument against the use of the new type; we want new types, new solutions. We are entering into a period when the art of the structural designer will have more freedom from restrictions of precedent; this benefits both the type of construction and the standing of the profession. But it is clearly important that we correlate our experience with standard forms to the theory to be used in designing the new type.

Object of structural analysis

We may distinguish (a) analytical procedures which are intended as tools of research, and (b) procedures which are intended as tools of design. In research, again, we may distinguish analytic research from experimental research. A complicated and erudite method of analysis may be quite useful as a method of studying certain phenomena in detail as a preliminary to devising a simple procedure for purposes of design. An obvious example is the value of Westergaard's classical work on slabs as a preliminary to current adaptations of it to design.

Research Analysis—Prof. Eddington is quoted as saying recently that "No experiment is worthy of credence unless supported by an adequate theory." With this paradoxical statement the writer agrees. Further, not only is the adequate theory necessary after laboratory experimentation for illuminating the data, but it is very much needed before experiments are begun, in order to plan the tests properly. Many procedures have their greatest value in the field of research, and it is necessary that the practical man understand that much material which

seems so useless to him is not intended for his immediate use. Designers have often been too quick, rather than too slow, to incorporate directly the results of research, either analytical or experimental, in their design procedure. Sometimes they do not wait to determine whether the work has passed beyond the preliminary stage before accepting it as a basis for final conclusions.

The laboratory man is coming to demand more of the illumination of theory in planning his experiments, and it is safe to say that the period of indiscriminate testing, which was conspicuous years ago, will find less favor in the future.

Analysis for Use in Design—Theoretical developments may be intended to be applied to design only after these theories are supplemented by careful laboratory data and are further clarified and interpreted in terminology of design. Clearly, however, unless theoretical knowledge leads ultimately to an understanding of structural action and unless this understanding can be interpreted in terms of structural design, we have achieved only futility. The work of the structural analyst is valuable, then, only as it is ultimately useful to the structural designer.

The designer is accustomed to picture the possible deformations in a structural part, to weigh quickly but effectively the elements of chance involved in that picture, and to judge of the method of failure. Many do this with a quickness and accuracy which seems intuitive; others think they can do it, do it poorly and are dangerous. By adding definiteness of outline to his vague pictures, by familiarity with the simple relations of modern analysis, the man of structural vision learns to draw accurately pictures of more complicated structural action. By making some definite analysis, by putting down some figures, the designer whose structural vision is myopic escapes many pitfalls and may finally improve his vision.

If the tools of analysis introduce too many new technical terms, too many unfamiliar procedures, if the glasses do not fit the patient, the designers with a God-given structural vision may go blind and the astigmatism of those designers whose structural vision is blurred may be accentuated. If structural analysis does not finally hitch up with structural sense, structural engineering is going backward.

Desirable qualities of analysis

We may identify certain desirable characteristics of methods of analysis:

1. The method should be easy to learn and easy to remember. It should introduce as few new technical terms as possible, and such technical terms as are used should be quite familiar to those who are to use the method.

2. The method should not only not introduce new technical terms but should by preference introduce no radically new *concepts*. The type of concept which is presented should be familiar to the sort of person who will use the method. For designers, this means that the method should be easily correlated with the accumulated experience of structural engineers. When a theoretical investigation departs so radically from the concepts with which designers have been familiar that the designer either has to abandon previous concepts completely—throw away his accumulated experience—or else disregard the theoretical investigation, the writer has little doubt that the designer will wisely cling to his experience.

Thus, it is quite possible to find bending moments in one loaded span of a continuous frame by finding the equivalent elastic areas of all members beyond the loaded span and then analyzing this span by the column analogy. But this is a far-fetched concept, though the writer could cite cases where for purposes of research it has considerable value; designers do not see column analogies in the field, but they are accustomed to visualize the effect of joint rotations.

3. One of the most desirable characteristics of an analytical procedure to be used in design is that it shall enable us to see the approximate answer from the beginning. The first estimate furnished may be considerably in error, but the method should indicate at once the general order of magnitude of the quantity with which we are dealing. It seems very desirable that subsequent operations should revise rather than reconstruct the original picture.

To take a very simple case, suppose we wish to compute stresses, for some condition of loading, in a continuous truss. A traditional application of Maxwell's procedure would be to remove the center reaction, compute the deflection there and then compute the value of this reaction to bring the center support back to its original level. A procedure often better than this, however, is to guess at the center reaction as well as we can, then compute the deflection and find the additional reaction required to bring the supports level—the error in our guess. The advantage is that our guess, if it is at all good—and it can scarcely be very bad in this case—tells us at once about what stresses we are dealing with; and our revision of this guess helps us to guess better next time—so that we are developing analytical judgment.

If a student wishes to become familiar with the theory of arches, the writer thinks that the best way is for him to draw by eye pressure lines for various conditions of loading that "hug" the arch axis as closely as possible; then compute the correction to the reactions. The original guess usually cannot be very bad; the corrections are—or should be—small; we see at once about what the moments are, and after a little experience we can draw the original pressure line very well and learn to see from the beginning how variations in the design are likely to affect the result.

Flexibility is important

4. Finally, it is desirable—one would feel tempted to say that it is *necessary*, if we were not so far from realizing it—that the method of analysis shall be flexible. This means that it shall without modification take account of any and all variations that occur in the material, that the effect of cracks, of soft spots and local irregularities may be readily estimated.

In most cases we are very far from this ideal at present. No one should expect that structural designers will adopt theoretical procedures that are incapable of even estimating the effect of such variations. In many procedures that have been presented one finds the prohibitive limitation that it is necessary to modify the structure hopelessly to fit the method of analysis, and it seems quite impossible to fit even approximately the method of analysis to the actual structure.

A series of parallel beams sharing a load on the same span cannot work together effectively if of slightly different depths—if Hooke's Law holds! Really they are quite effective if the difference of depth is not great—we must think beyond Hooke's Law. The analysis of slabs of reinforced concrete is quite unsatisfactory because we cannot conveniently include the effect of cracking. Analyses indicate certain distributions of reinforcing steel, whereas often quite different distributions are just about as effective. It may be added that no one has pointed this out more clearly than has Westergaard.

Novelty and speed versus simplicity

It will be noted that among the desired characteristics enumerated, novelty is not included. The field of structural analysis is one in which new ideas have frequently been presented because of their apparent novelty alone. Of course, if the method differs in no way from previous methods, it should not be published. But there is nothing new to be said in regard to the laws of statics and dynamics, or in regard to geometry. The facts are very simple, and they are true for a very long time. New properties may in some cases be brought out with regard to materials. What is needed at present is a clearer, more definite, more flexible restatement and correlation of fundamental procedures.

Many would emphasize that the method should be rapid. This depends on how often it is to be used, for what purpose—routine design or special design—it is to be used, and who is to use it. Professors and graduate students working on theses and other academicians

who work in offices seem inclined to overestimate the importance of saving a few minutes in a design problem which comes up once a month or once in a professional career. *Simplicity is more important than speed.*

Type of thought used in analysis

What type of thought is used in the analysis of structures?

In a certain sense the answer can be stated very simply. The structural analyst attempts to find the stress distribution in a given structure under a given loading which does three things: First, the stresses must satisfy the law of statics; they must be in statical (or, in certain cases, in dynamical) balance throughout the structure. Second, the strains produced by the stresses must satisfy geometry; they must not produce any discontinuity or break in the structure unless it is known that such discontinuity actually occurs. Finally, the relation of stress and strain must be in accordance with the known properties of the structural material with which we are dealing.

It is to be noted that the first two matters are in no way open to argument or discussion. Geometrical principles are not a proper subject for testing, statics is not a proper subject for testing. Where the relations, geometrical and statical, are perfectly clear and the properties of the material relating the statics to the geometry are perfectly definite, testing may have illustrative value but can scarcely have value as scientific demonstration. Where the geometrical and statical relations are not perfectly clear, tests may help our understanding of the problem, though ultimately these relations must be made clear by analysis. But where the properties of the material are uncertain and variable, tests may furnish valuable statistical data bearing on the effect of chance.

It is very desirable that the solution of a problem in stress analysis be so stated that anyone familiar with the subject may see whether the forces balance throughout the structure and whether the deformations are consistent with continuity in the structure. Thus, a pressure line for a fixed-end arch has the virtue that anyone can see, at least approximately, whether it fits the axis.

The picture-puzzle analogy

Omitting for the present any consideration of variations in the properties of the material, we return to the question of how we are to find a solution that will satisfy the three conditions: (1) that stress must balance, (2) that the strain must be continuous, and (3) that the relation of the stress to the strain must agree with the actual physical properties of the material.

Finding such a solution is very much like solving an ordinary picture puzzle. To solve such a puzzle: (*a*) Make the pieces fit together—geometry—so that (*b*) the colors harmonize—statics—but (*c*) do this without using parts of different puzzles, without attributing to one material, such as concrete, properties that are true only for another material, such as steel. When a picture puzzle has been solved, there is no question whether the solution is correct. In order to find out whether it is correct, one does not ask by what system the pieces were put together.

One of the most powerful methods of analysis is, in a sense, no method at all—namely, to guess at a solution and then see if it satisfies statics and continuity. *The faculty of guessing at solutions is capable of great development. One of the chief values of formal analyses is to aid in its development.*

Sometimes we find a clue to a puzzle from the fact that we have solved similar puzzles, and we suspect that the gray color represents clouds at the top of the picture or that the brown earth goes at the bottom. This may mean that we suspect that a certain type of function may furnish a solution of our differential equation.

Geometrical and energy methods

We sometimes hear a vague statement that the methods of analysis based on the principle of the conservation of energy and usually referred to as "methods of work" achieve in some way an elegance and precision not characteristic of methods based immediately on geometrical conceptions. Such ideas, of course, have no foundation; the statement of problems in terms of geometry and the statement in terms of energy are identical statements.

We need not go here into a general discussion of the interrelation of the principles of statics, the principles of geometry and the principles of energy conservation. It may, however, be worth while to point out the identity of the relations in a simple case.

Suppose we have a weight suspended by two wires of different physical characteristics. Statics tells us that the whole weight P is taken by the two wires, and we can write

$$P_1 + P_2 = P \qquad (1)$$

The stretch of each wire is proportional to the load that it carries, multiplied by a constant representing the physical characteristics of the wire. Call this constant C. The stretch is the same in the two wires, and we write

$$P_1 C_1 = P_2 C_2 \qquad (2)$$

By formal algebra we can now deduce the values of P_1 and P_2, or in a less formal way we may see at once that the weight P is distributed between the two wires in inverse ratio to their C values.

If in Eq. (2), which is plain geometry, we substitute $P_2 = P - P_1$ from Eq. (1), which is pure statics, we have the equation of the condition of minimum internal work in the system. But it does not appear that thereby we have achieved any particular elegance, and it is clear that we have not added any elements not already contained in the problem.

Geometrical methods are clearer

Geometry is almost certainly the more familiar tool of thought to the structural engineer. The use of the energy relations may, it is true, sometimes avoid certain difficulties in setting up the formal statement; but what the engineer ultimately wants is a picture of the action of the structure, and this, at least for problems of statics, will be in terms of geometry.

The writer finds the geometrical picture clearer and more convincing even in problems in dynamics, but in such problems consideration of the energy involved has obvious advantages.

The concluding half of Professor Cross's article will appear next week.
—Editor.

Omaha Water Sales for 1934 Reported

Last year water pumped from the Missouri River, filtered and purveyed to the 218,000 people in the Metropolitan Utilities District of Omaha, Neb., exceeded in volume that of any previous year. It averaged 29.4 m.g.d. as against 26.2 m.g.d. in 1933 and 29.0 m.g.d. in 1930, the previous high. In gallons per capita this means 135, of which 84 per cent was dispensed through 49,193 meters of the 52,285 services in the District. The average cost per 1,000 gal. sold, exclusive of sinking fund and all other reserves, was 8.71c. made up as follows: pumpage, 3.31c.; distribution 1.1c.; general expenses, 1.74c.; bond interest 2.56c.; sinking funds and other reserves brought the cost up to 14.29c. Operating income was 14.4c. per 1,000 gal., and income from all sources was 15.88c. For the average residence the annual cost is $10.75, about half what it was prior to acquisition of the plant from the Omaha Water Co. in 1912. Exclusive of depreciation, estimated at $2,900,000, the present book value of the plant is $12,600,000 against which there are liabilities of $5,000,000, mostly in 4½ per cent bonds due six years hence.

No construction work of magnitude was carried on during 1934 aside from 34,000 ft. of mains. Theodore A. Leisen is general manager.

Colorado River Desilting At Imperial Dam

Removal of 60,000 tons of silt per day by circular scrapers will save $1,000,000 annually in cleaning charges on All-American Canal—Design based on extensive silt subsidence research and on model studies of various dam structures.

BUILT to divert 15,000 sec.-ft. of Colorado River water into the All-American Canal, the Imperial diversion dam involves far more than ordinary irrigation headgate structures. Most important and novel of the new elements are the desilting basins, equipped with circular scraper mechanisms designed to remove a large part of the 60,000 tons of silt per day which estimates indicate would otherwise be carried into the canal and entail a yearly cost possibly in excess of $1,000,000 to remove.

Silt occurrence, subsidence and removal have been the subjects of an enormous amount of research. Every structure of the dam and headworks has been modeled and studied individually, and finally a 1:40 model of the dam and 1½ miles of river were tested at Montrose, Colo. In consequence these works represent one of the most scientifically designed hydraulic structures in the country.

Aside from piers and abutments, which are founded on concrete piles, jetted and driven 45 ft. into the fine compacted sand, the main dam, 31 ft. high, is a hollow structure of floating type with the concrete sections 79 ft. long, flexibly connected, to care for small subsequent settlements. Along the center line of the dam are four essential structures. Starting on the California side are four 75-ft. roller gates, letting water into as many channels leading to the desilting basins; next a sluiceway with twelve radial gates that is expected to take all the normal surplus water and provide a medium to carry away the removed silt; then a 1,200-ft. ogee hollow concrete overflow section with an elaborate underdrainage system and upstream and downstream concrete aprons, the downstream one 8 ft. thick on which the hydraulic jump is to be formed; and finally a radial-gate section on the Arizona side for headworks for the proposed Gila Valley canal if, as and when built. This latter section will constitute the diversion channel during construction.

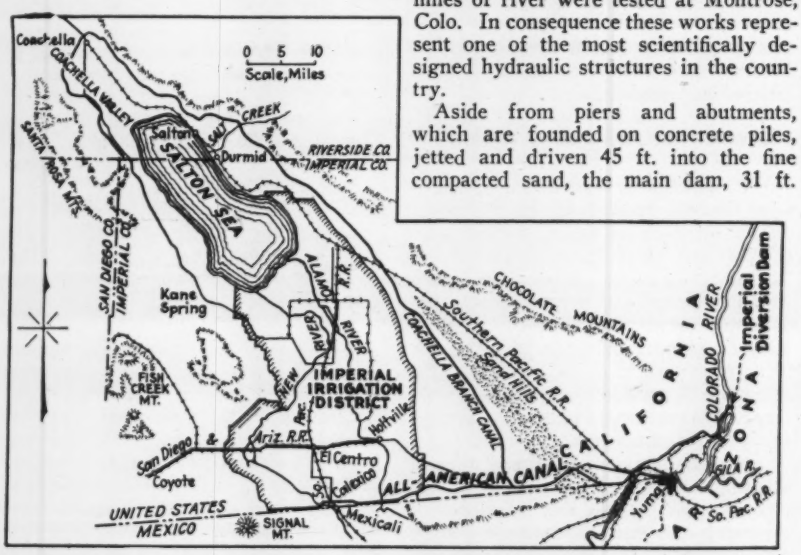


FIG. 1—WATER WILL BE CLARIFIED at the Imperial diversion dam, 250 miles south of Boulder Dam, before it flows to the irrigation district served by the All-American and Coachella Branch canals.

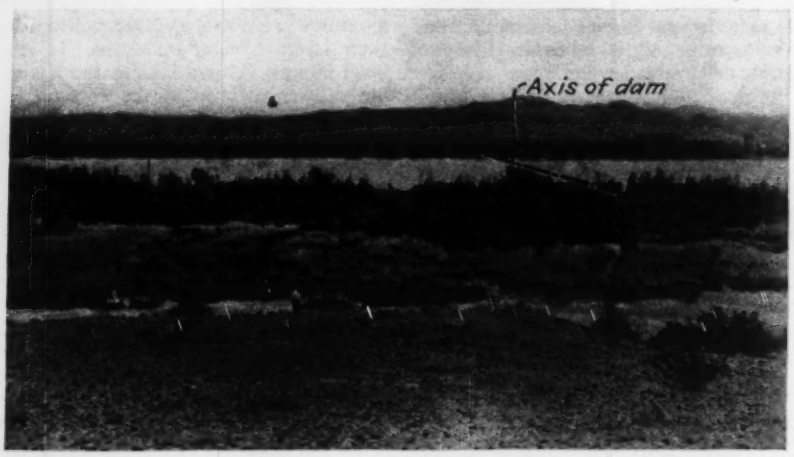


FIG. 2—AT IMPERIAL DIVERSION DAM site the low river banks are of rhyolite rock.

The dam is located 17 miles above Yuma, Ariz., and 4½ miles above the present Laguna Dam, which diverts 2,000 sec.-ft. of water into the canal leading to the Yuma Valley irrigated area. Silt has been removed at Laguna rather successfully by intermittent operation of gates in a sluiceway at the end of a long skimming weir. Immediately below Yuma, near the Mexican border, is the Imperial Canal headgate or Rockwood heading, with no adequate desilting arrangements. Silt deposited in the canal and laterals of the Imperial Irrigation District costs annually $800,000 for removal, which is the principal economic reason for the elaborate research and the decision to build desilting works at the head of the All-American Canal.

Features of the silt problem

Contrary to layman belief, Boulder and Parker reservoirs for many years will have little effect on the larger-sized (larger than 300-mesh) silt content of the river at Imperial Dam. The dams forming these reservoirs are respectively 300 and 150 miles upstream, and although they produce clear water, the pickup from the bed of the river soon loads the stream to capacity. Elaborate investigations have indicated that the quantity carried in suspension is practically proportional to the discharge.

Of the material smaller than 300-mesh, which is found in the river banks and brought in by cloudburst flow from tributaries (many of them dry streams) and Bill Williams River, the amount is variable and not proportional to the discharge. Further, this fine material will not settle in short detention periods or deposit in the canals to any appreciable extent but will pass on to the laterals and the irrigated land. The works then are and can be concerned only with the material larger than 300-mesh. Total silt content of the river has been observed for more than 20 years, but for the last 2 or 3 years close research has been made on the distribution and amounts of the different sizes.

Since the Boulder Dam gates were closed, intensive study of silt content, riverbed erosion and profile of bed and water surface has been carried on in a 12-mile stretch below the dam. The diversion conduits soon began to pass clear water, but erosion of the riverbed began immediately below, and appreciable reduction in the profile grades below Boulder Dam is already apparent (see chart Fig. 4.) Enough of transportable material still exists in the riverbed, as well as in the banks subject to side wash, to furnish this silt load for many decades. As the profile flattens the erosion will extent progressively farther downstream. It is therefore expected that silt will be removed from the riverbed and banks below Boulder and Parker dams and be deposited in the reservoirs downstream. The Parker reservoir has sufficient capacity to hold all the silt that will come in for a great many years, but the reservoir behind Imperial Dam will soon fill up. The silt entering the All-American Canal is expected to increase to a maximum and then slowly decrease as the river upstream is stabilized.

Reasons for desilting

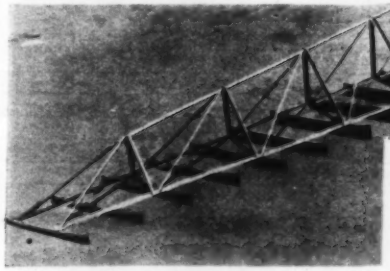
No appreciable reduction of the coarser material has taken place in samples tested at Imperial but, as expected, some reduction has taken place in the amount of the finer material. The amount of material entering the All-American Canal headgates will be influenced by the gradual filling of the Imperial reservoir and the building up of the riverbed.

If no desilting takes place at the headworks, deposition will occur in the canals, especially in the early years, when the normal velocities of 3.75 ft. per sec. will be reduced to 2 ft. or lower. High velocities might be used in the canal, but loss of power revenue would result at Pilot Knob and other power plants and the silt would be carried onto the lands.

Transport along the river of the silt removed from the desilting basins is by surplus water through the sluiceway. Some 6,000 sec.-ft. is the quantity estimated as necessary, and this is calculated to be available for many years. While these and other figures cannot be checked closely, the best judgment of many hydraulic experts indicates a tremendous silt load, which if not removed will give rise to difficulties and costs many times more than the annual charge for removal.

In accordance with the specifications for the purchase of the mechanical desilting equipment, basic designs were made on the following assumptions: The flow is 12,000 sec.-ft., or four-fifths of the future 15,000 sec.-ft. The 12,000 sec.-ft. contains 60,000 tons of silt coarser than 300-mesh, but for maximum load 50 per cent was added, making the total 90,000 tons. This amount is expected to reduce to 20,000 tons, being about an 80 per cent reduction of the maximum load. Ordinarily with a 60,000-ton content the influent will be a 0.2 per cent "solution," the effluent in the canal 0.04 per cent and the "sludge" 10 per cent. The 12,000 tons in the canal water will be the finest portion.

The maximum velocity in the desilting basins is 0.24 ft. per sec. and the efficiency of desilting has been calculated from formulas developed by the bureau engineers and based on the classic paper by Allen Hazen (*Transactions*, A.S.C.E., Vol. 53, 1904, p. 45). The detention period is 14 min., and the depth of basin 12½ ft. sloping to 14 ft. at the central draw-off wells of the scraper mechanisms.



Numerous researches and calculations were made of the power required to move the silt. Tests indicated that it requires 1 lb. pressure to push sidewise 1 lb. of silt (dry weight). Calculated power requirements were checked by models and resulted in calls for 7½-hp. motors on 125-ft. machines for the first row of clarifiers handling the heavier silt near the inlets and 3-hp. motors for the second row. The assigned rate of deposition was as noted in Fig. 5.

Operation of desilting basins

The desilting works consist of six 269x769-ft. settling basins set at an angle of 60 deg. with the influent channels, to permit arranging the 125-ft. circular scrapers to give minimum interspaces. Each basin has a rated capacity of 2,000 sec.-ft. Provision is made for another pair of basins, to bring the total capacity to 16,000 sec.-ft. Pairs of basins are fed by an influent channel of diminishing cross-section located between basins; the water enters the basins through vertical slots of special design and travels the short way across the basins to overflow weirs into effluent channels leading to the All-American Canal. The effluent channels may also be operated as bypasses around the basins. Together with the influent channels they are controlled at their upstream ends by radial gates.

Deposited silt will be removed by 72 rotary scrapers specially designed for handling this type of load. Curved blades attached to two opposed arms supported on a central concrete pedestal scrape the silt in windrows successively to a circular trench, from which it is flushed to a system of sludge-disposal pipes and thence into the sluiceway channel. V-shaped plows fitting into the circular trench bring the sludge to the four effluent pipes that rise in the central well to an adjustable sleeve weir to control the amount of discharge.

FIG. 3—CLARIFIER MECHANISM, one of 72, to be installed at Imperial desilting works.

Sludge pipes are of manganese steel, on which no undue erosion is expected to occur under the 6-ft. velocity of the 10 per cent concentration. Rubber-lined pipes were considered, but the cost appeared prohibitive.

All bearings were required to be out of the water to avoid wear by the silt. The supporting cage for the scraper arms is supported on a ball-bearing ring 10 ft. in diameter with 1½-in. balls. The motors, which operate at 1,800 r.p.m., are centrally located over a speed reducer and train of alloy steel gears to drive the arms at 1/13 r.p.m. The peripheral speed is 30 ft. per min.

A special feature of the design permits the scraper arms, which are of structural-steel triangular frame, to rise when the load becomes excessive due to any cause such as stoppage or to material sliding in from the interspaces. The arm is hinged at the connection to the cage on the ends of the diagonal member, the third end resting in a slotted adjustable stop. Thus when a certain load is reached, the outer end of the arm carrying the scrapers rises in a backward and upward direction.

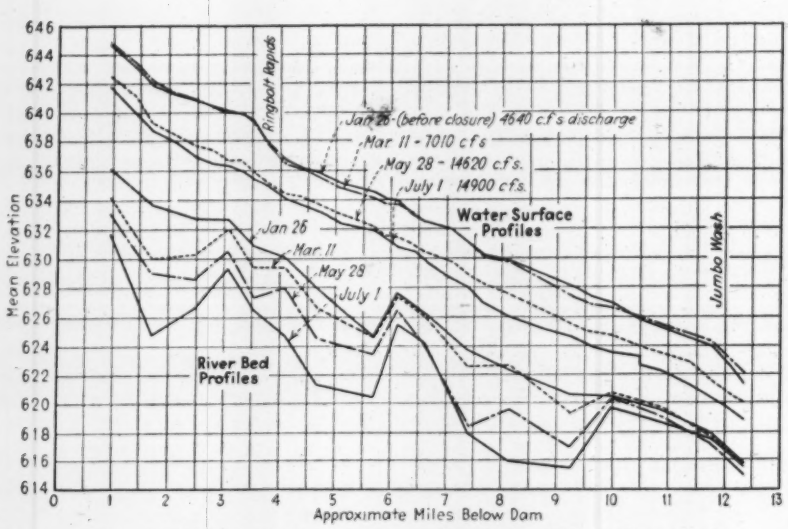


FIG. 4—EROSION in the Colorado River below Boulder Dam is shown by the changing riverbed profile after closure of gates on Jan. 31.

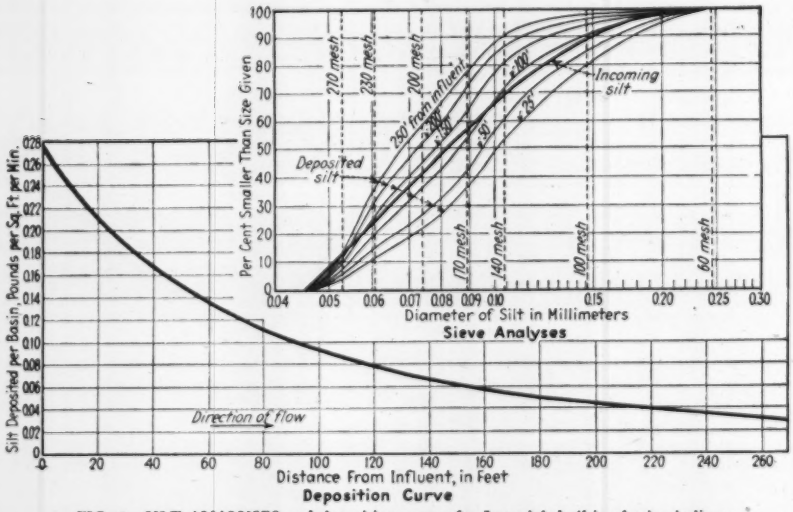


FIG. 5—SILT ANALYSES and deposition curves for Imperial desilting basins indicate the distribution of the silt load in the basins at various distances from the influent.

Foundations for the scraper mechanisms are circular concrete pedestals, but there is no floor in the basins otherwise, the silt building up to the scrapers. A portion of the excavation for the tanks will be in rock, and it is planned to use this rock for riprap.

Roller gates for flow control

Controlling the water entering the influent channel leading to the desilting basins are four 75-ft. rolling lift gates, 14 ft. in diameter and 23 ft. high to the top of the flash weir. The normal flow through one gate is 4,000 sec.-ft. Modernistic houses surmounting the piers of a pair of gates enclose the lifting mechanisms. Each gate supplies a pair of basins, channels downstream being separated by a row of wood sheetpile division walls. Velocity at 4,000-sec.-ft. flow in these channels is 6 f.p.s., and between the basins is 7 f.p.s.

A control house will be centrally located on a hill top near the west abutment. Here will be housed electric control of all gates, scrapers and other mechanisms and a switchboard for alarms and signals.

Arizona headgates

Headgates for the future Gila Valley canal are located at the east end of the overflow portion of the dam and consist of three groups of three radial gates, each 35 ft. long by 15 ft. high. Nothing below the gates will be installed now, but the openings will be used during construction as channels for river diversion. A settling-basin type of desilter is proposed, but final selection of type will await experience with mechanical scrapers. The latter use 4-ft. head, and all of the 6,000 ft. of diverted Gila Valley water will be pumped so that requirement may preclude the use of mechanical desilters. The basin method requires but a few inches hea

Sluiceway for surplus water

Twelve radial gates, 16 ft. long and 7 ft. high, will control the entrance of water into the sluiceway into which is discharged the "sludge" from desilting basins. It is contemplated that all ordinary surplus water will be disposed of here, and only on rare occasions will the overflow section of the dam be needed. The capacity is 24,000 sec.-ft. concentrated in a confined channel planned ultimately to extend 4½ miles to the entrance of the Laguna sluiceway. At present it will terminate at the lower end of the desilting basins.

It is not expected that the flow to Imperial Dam will exceed 50,000 sec.-ft. normally, and with a factor of 3 this gives 150,000 sec.-ft. as the maximum to be cared for. With 24,000 sec.-ft. through the sluiceway, 15,000 diverted to the All-American Canal and 6,000 to the Gila Valley, some 45,000 sec.-ft. is provided for, leaving the overflow crest to take care of 105,000 sec.-ft.

Weir section

Design of the overflow crest section of the dam consists of 1,200 ft. of a hollow reinforced-concrete dam built in 79-ft. monolithic sections, articulated and water-sealed with a special type of rubber seal to permit slight settlement, since the foundation is sand finer than ¼ in. with rock some 200 ft. down. The crest is 26 ft. above the present riverbed. The foundation will be prepared by rolling. Maximum pressures will be 4,000 lb. per square foot. Each base slab will be surmounted by four buttresses on 20-ft. centers, and a portion of the space between buttresses will be filled in with sand to provide additional weight against uplift.

Downstream for 70 ft. is an apron 8 ft. thick provided with two sets of dentated sills to facilitate the formation of the hydraulic jump, all of which will occur on the concrete apron. The first series of sills has the vertical face downstream, while the second set of sills at the end of the concrete has faces alternating up and downstream. Below the concrete is a 150-ft. section of placed rock and riprap. At the end of the concrete is a row of 32-ft. steel sheetpiling to minimize seepage and possible erosion. Action of this apron and sills has been carefully studied in many models. Upstream is a 170-ft. section of apron under which are two rows of 24-ft. wood sheetpiling, and near the upstream toe of the dam there is a row of 40-ft. steel sheetpiling to prevent piping.

Underdrains provided

To reduce uplift and prevent blowouts, inverted filter drains are placed under every part of the dam and gate structures. These lead to pipes in the weir section coming up 10 ft. above the base

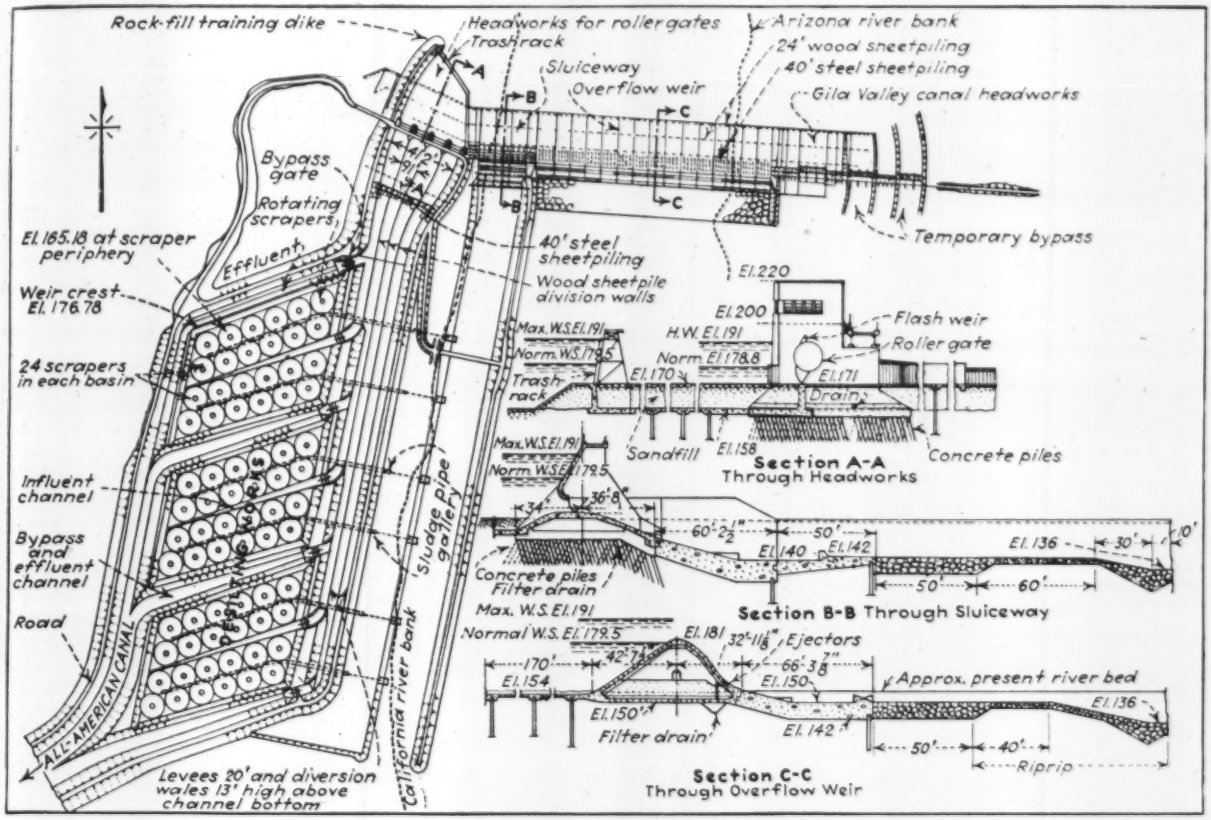


FIG. 6—IMPERIAL DAM with mechanical circular scraper type of desilting works also includes headgate, sluiceway and overflow structures. Sections through various structures show interesting details of hollow dam with sand fill and underdrain system with ejectors.

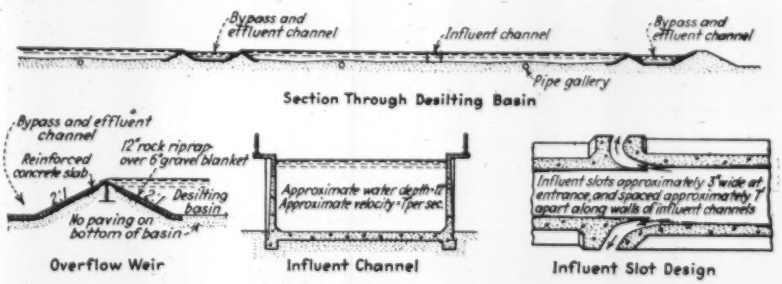

Bypass and effluent channel
Influent channel
Bypass and effluent channel
Pipe gallery
Section Through Desilting Basin
Bypass and effluent channel
Reinforced concrete slab
12" rock riprap over 6" gravel blanket
Desilting basin
No paving on bottom of basin
Overflow Weir
Approximate water depth-12'
Approximate velocity-1' per sec.
Influent Channel
Influent slots approximately 3" wide at entrance, and spaced approximately 7' apart along walls of influent channels
Influent Slot Design

FIG. 7—DESILTING BASIN details showing novel design of the influent channel.

of the dam and connecting to ejector pipes for dewatering. Work on models is under way to determine the best form of filler around the drains to prevent the entrance of silt. Under abutments and all other portions of the structures supporting gates or other mechanisms are 45-ft. reinforced-concrete piles jetted and driven down. These piles are anchored into the concrete above by cutting back the concrete of the pile head and exposing the reinforcing bars. They are battered in two directions and provide for shear as well as pressure. Tests have been made to determine safe working loads for compression and tension into which most of the shear will be translated by reason of the battering and anchoring.

Equipment contracts

Low bidder on the roller gates was the Dravo Contracting Company, Pittsburgh, and award has been made for the 72 rotary scraper equipments to the Dorr Company, Inc., New York City.

The Imperial Dam and desilting works are financed under the $4,800,000,000 Relief Act but were authorized under the Boulder Canyon Act. Design and construction are being handled by the U. S. Bureau of Reclamation of the Department of Interior, Harold L. Ickes, secretary. Dr. Elwood Mead is commissioner of the Bureau, R. F. Walter chief engineer, S. O. Harper assistant chief engineer, and J. L. Savage chief designing engineer. Model testing has been under the supervision of E. W. Lane, research engineer. Design has been handled in the canal section of the Denver office, H. R. McBirney head, and C. P. Vetter in charge of diversion dam design. R. B. Williams is construction engineer for the All-American Canal system of which the headworks is a part.

The board of consulting engineers for the Bureau, Louis C. Hill, Charles P. Berkey and W. F. Durand, has reviewed and advised on the tests, researches and designs, finally approving the designs at a meeting in Washington July 22-24. The late D. C. Henny was a valued member of this board up to the time of his death.

Bridge Ruling Reversed

The decisions of the Dominion Exchequer Court and the Quebec Admiralty Court (the latter reported in *ENR*, Jan. 25, 1934), ordering the owners of the steamer "Philip T. Dodge" to pay up to $35,059 for damages to a swing bridge across the entrance to the York River in Gaspe Basin, P. Que., during the construction of the bridge in 1932, were reversed on July 30, in London, England, by the Judicial Committee of the Privy Council, the highest legal tribunal of the British Empire. The appeal from the decision of the courts was allowed with costs, by the Privy Council, except in so far as issues raised in connection with the allegation that the bridge was wrongfully constructed. The decision is of special interest in view of the strong local feeling against the bridge.

Research Notes

Current Studies at Iowa State College

By W. J. Schlick
Drainage Engineer, Engineering Experiment Station, Iowa State College, Ames, Iowa

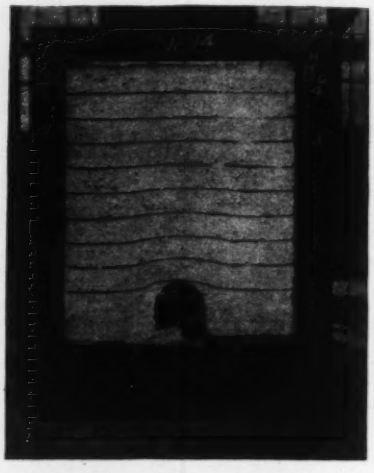
ENGINEERING research at Iowa State College is conducted primarily on the project basis through the Iowa Engineering Experiment Station, though the contributions from personal studies by staff members and graduate-credit studies are noteworthy. The selection of problems has always been dictated largely by the interests of the staff, within the limitations of funds and time and with special attention to problems of particular interest to Iowa. The following presentation of civil engineering studies makes no mention of valuable researches in other fields, nor does it attempt to give detailed statements of all the problems mentioned or to give personal credit to the men who are directing and conducting the work.

Underground conduits

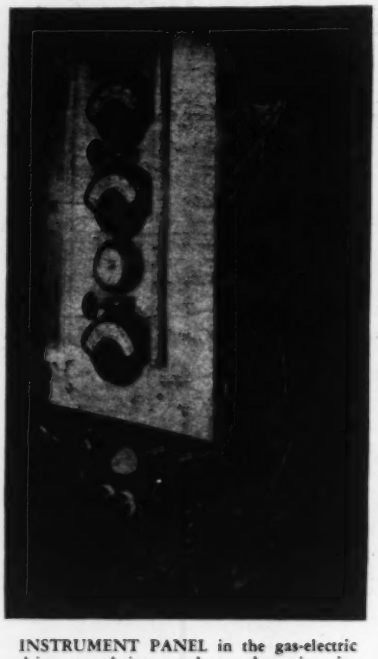
The most extensive research of interest to civil engineers is that started in 1907 by Dean Anson Marston (now Senior Dean of Engineering) on the loads on sewers and drains and the strengths that they would develop with the laying methods commonly used. This work has been expanded to cover practically the whole field of the rational structural design of rigid pipe conduits in ditches and under embankments; the calculation of the loads, due to both fill materials and surface loads, upon all types of conduits; and some portions of the problem of the strengths of flexible conduits. The current activity in this field touches many phases of the general problem.

Work is now under way on the preparation of a complete presentation of the theories and ratios for rigid pipes in ditches, and of the supporting experimental data. Also, the theories for the loads due to fill materials on projecting conduits are being reviewed and extended, and working values of the various constants determined, on the basis of experimental data and examinations of actual field structures. Many of these data were collected in cooperation with the U. S. Bureau of Public Roads.

Three similarly constructed culverts (reinforced concrete, cast iron and corrugated metal pipe, all of 42-in. size) loaded by a 15-ft. loam fill have been under observation since 1927. These long-time records show that the loads are fluctuating without material change in the peak loads, but that the vertical diameters of the pipes are decreasing gradually. The load, deformation and intensity and distribution of peripheral pressures are being measured for another corrugated metal culvert under a 16-ft. gravel fill. These records and those for the corrugated metal pipe above will be utilized in an attempt to develop a rational method for the structural design of flexible pipe culverts.



MODEL illustrating the settlements in a fill over a culvert.



INSTRUMENT PANEL in the gas-electric drive car being used to determine influence of the roadway surface on power requirements.

The strengths of cast-iron water pipe, 6 to 48 in. in diameter, with different laying conditions and internal water pressures, are being determined as a part of a larger study being made jointly by the Illinois Engineering Experiment Station and this station for the American Standards Association committee on specifications for cast-iron pipe. These data furnish the basis for an empirical relationship for the combination of the flexural stress due to external load and the tensile stress due to internal pressure, and will make possible a more rational method for the structural design or selection of cast-iron water mains.

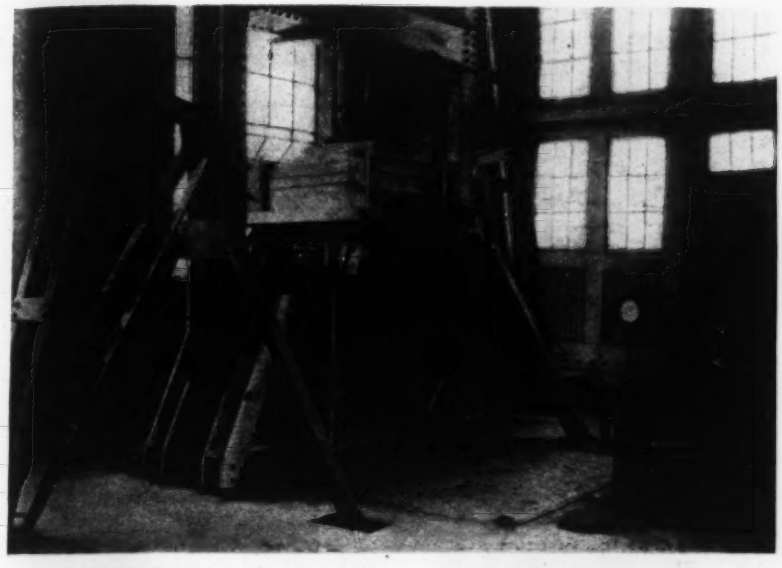
Highway transportation

The researches in the general field of highway transportation were started in 1919 when Dean T. R. Agg (then professor of highway engineering) initiated studies of the operating characteristics of motor vehicles and roadway surfaces. As the work has been expanded to other phases of the general problem, changes in highway standards and in automotive vehicles and tires have necessitated almost continual checking and extension of the various ratios and costs.

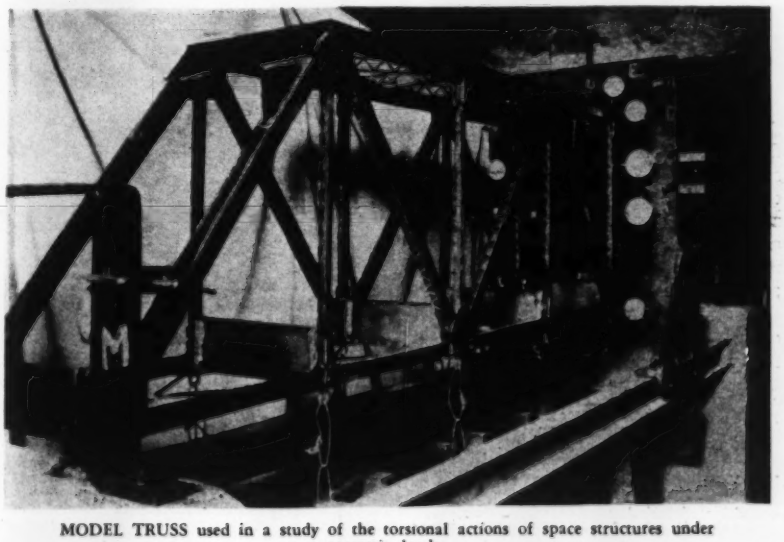
Safety in automobile travel is the objective of a current study in which the braking requirements and the safety requirements on curves are determined and correlated with the coefficients of friction for tires of different sizes, types and treads on all of the common types of surface under a wide range of weather conditions.

The costs of operating motor vehicles are being obtained in three studies. One series of determinations with six passenger cars and two trucks shows that there is a marked decrease in the miles per gallon of gasoline as the speed is increased above 25 miles per hour; and that the fuel consumption is greater on ascending-descending grades, the difference being more pronounced for passenger cars when the grades are steeper than 6 per cent and with trucks on grades steeper than 3 per cent. The influence of the roadway surface upon the power required is being studied with a gas-electric drive car traveling over a wide variety of surfaces, especially of the newer types. Measurements of the power delivered to the driving motor, of the speed, the wind velocity and the gasoline consumed give a complete picture of the power requirements under different conditions. An extensive study of the actual costs of operating motor vehicles, as influenced by roadway grades and climate, is being undertaken in cooperation with the National Association of Rural Letter Carriers.

A study of pavement life, in which actual construction and retirement rec-



DETERMINING the supporting strength of a section of 48-in. pipe on an earth bed, with tamped backfill and with internal water pressure. Special gaskets are used between the bulkhead plates and the test section, to minimize the restraint against deformation.



MODEL TRUSS used in a study of the torsional actions of space structures under eccentric loads.

ords will be analyzed by valuation methods, is under way in cooperation with the Bureau of Public Roads. Results are now available for Wayne County, Mich., Buffalo, N. Y., and Des Moines, Iowa; those for the state systems in Michigan and Massachusetts will be completed soon.

Structural engineering

The current researches that may be grouped under this general heading cover a wide variety of problems.

Analyses to date of the experimental data for the actions, under vertical and horizontal loads, of a building frame, in which split I-beam sections are substituted for the usual connection angles, indicate that such connections may be considered as essentially rigid. In another study a model (1:20 scale) of a single-track, through-truss railway bridge of 150-ft. span is proving satisfactory for study of the torsional actions of such structures. Measured deflections of the model under eccentric, vertical loads are in close agreement with those calculated for a space structure.

Short sections of full-scale reinforced-concrete box culverts are now being tested as the first part of a study intended to develop a laboratory method for determining the supporting strength of such structures and to correlate that strength with design strength and field supporting strength. The distributions and intensities of the lateral pressures against retaining walls, due to a concentrated load on the surface of the fill, have been measured for several standard wall sections, permitting the development of empirical formulas.

The strengths and actions of pavement slabs are being studied with large-scale concrete slabs on earth foundations, with model slabs of plaster and steel, and in a more general mathematical investigation of the effects of moving loads on slabs on elastic foundations. Measurements of the strains due to corner loads in the first of the concrete slabs on a clay subgrade show the distribution of the stress in the top face over the whole corner region. The location and distribution of the highest stresses indicates an hypothesis somewhat different from that previously used. The model study using plaster slabs on an elastic (rubber) foundation shows typical corner and edge failures but has not progressed far enough to warrant other conclusions.

The results for a number of large-scale, simply supported, reinforced-concrete floor slabs with concentrated loading show the distribution of the shear and have permitted the development of an empirical formula for its lateral distribution. This study is utilizing the results of a mathematical study of the general problem of slabs of various thicknesses, freely supported at all edges, and subjected to concentrated loads.

Engineering materials

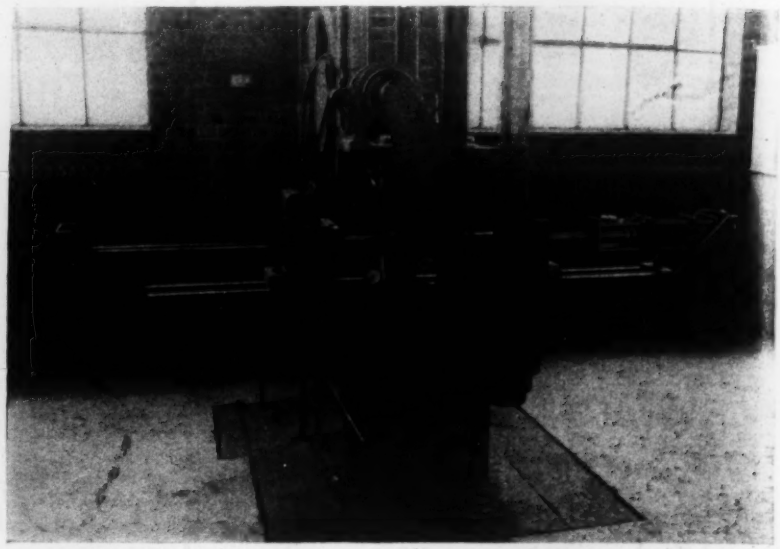
The current researches in this field, like those in structural engineering, relate to a variety of problems and materials.

A project (cooperative with the Highway Research Board) on the use of high elastic limit steels for concrete reinforcement includes studies of relative economies in the use of such steels and of various other factors. An interesting tentative indication is that relatively high sustained loads do not necessarily result in corresponding increases in the widths of the cracks in the tensile face of the member. It appears that the steel has relatively little tendency to flow and that the yielding must, therefore, occur largely in the compressive concrete.

An investigation of the effectiveness and permanence of pigments for coloring concrete indicates that fading occurs with most of them and that some pigments are injurious to the concrete. A photographic method is employed for definite measurement of color value and intensity. A comparison of 2-in. cubes, 2x4-in. and 3x6-in. cylinders and 2x2x4-in. prisms as portland cement mortar compressive specimens indicates that the prisms give strengths slightly above those of the cylinders and below those of the cubes. The prisms have the advantages of being cast on the side with plane ends, like the cubes, and of having sufficient length for the measurement of strains, as do the cylinders.

A study of the permeability of concrete has resulted in the development of a workable method of test and appears to indicate that impermeability is pro-

PERMEABILITY of concrete being determined from the rate at which water under controlled pressure passes through disk specimens.



APPARATUS USED for testing cast-iron specimens under combined tension and flexure.

portional to strength, whether this variation is due to the character of the cement, the water-cement ratio or the curing.

A study is just being completed in which the strengths and elastic properties of small cast-iron specimens, cut from plates of three thicknesses and of four grades of iron, were determined. The results should show the relationships between the physical properties of these irons and furnish a basis for a more detailed study of the action and strength of cast iron under combined tensile and flexural stresses. Other materials studies include two types of reinforced clay-block floor slabs and an investigation of the interrelationship between the physical properties of building stones.

Sanitary engineering

Iowa has had her share of the difficulties arising from the use of natural streams for the disposal of sanitary and industrial wastes, and as a result much of the sanitary engineering research has dealt with the treatment of such wastes. The current work is conducted partly by, and in cooperation with, the Agricultural By-Products Laboratory of the U. S. Department of Agriculture. The studies of this latter agency have dealt primarily with the utilization of the wastes, though generally utilization is accompanied by increased stability of the final wastes.

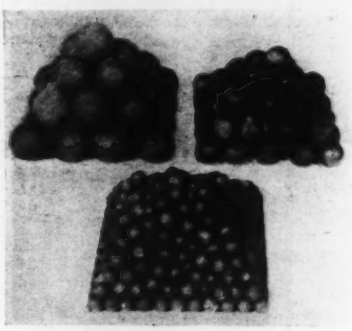
An investigation, in cooperation with an Iowa meat-packing plant, of the treatment of packing-house wastes has resulted in the construction of a plant that utilizes a washable primary filter and a coarse-grained final filter. This plant is accomplishing a reduction of 90 per cent in the oxygen demand of a waste having an original B.O.D. of 800 to 2,000. A study of chemical precipitation and biologic treatment of vegetable-cannery wastes is showing the limitations of seeding filters for plants having a short season, the degrees of purification possible in the different steps of the treatment and the factors controlling the digestion of the precipitated solids. A research into the possible utilization of the steep water from corn-sugar refineries indicates that it is a possible source of nitrogen for the fermentation of alcohols from waste sugars, leaving a nearly stable final waste. The fourth of the studies with industrial wastes indicates that the introduction of packing-plant sludge into fermenting masses of agriculture byproducts speeds up the rate of fermentation and the volume of gas so as to offer possibilities for small-community gas supplies, leaving a fairly stable effluent and a sludge that is valuable as a fertilizer.

A study of the fundamental principles underlying the biologic activities of trickling filters, as affected by rate of application and concentration of waste, aeration and temperature, is being started. The results of other studies, cooperative with the city of Ames, are showing the relative efficiencies of quartzite, corn cobs and two types of ceramic products as filter media and the conditions permitting the most efficient use of each. A few trials with a process developed in Germany indicates that Iowa peats are satisfactory filter media for private-home treatment plants.

A water-treatment study indicates that satisfactory and economical deferrization of underground and surface-water supplies may be accomplished under pressure by the proper introduction of air to oxidize the iron and sweep out the carbon dioxide.

Soil-erosion control

There are three current researches in the general field of soil-erosion control:



THREE SIZES of burned-clay spheres for use in the study of the fundamental principles underlying the biologic activities of trickling filters.

(1) A study of the costs and efficiencies of the types of gully-control structures built in Iowa by the CCC camps tends to show the most suitable and economical structure for each location. (2) Methods and costs of terrace construction on slopes up to 12 per cent are being studied in a new project utilizing FERA labor. It is expected that this study will show the costs of construction and maintenance of all types of terraces. A new terracing machine has been developed and indicates that the construction time per mile of terrace can be reduced from about 20 hr. with an ordinary blade grader and tractor to about 7.5 hr. with the new machine. (3) A study is under way of the applicability and efficiency of a new basin-forming lister (forming basins about 8 in. deep, 3 ft. wide and 6 to 8 ft. long) for use in orchard and pasture lands that are too steep for terracing and cultivation.

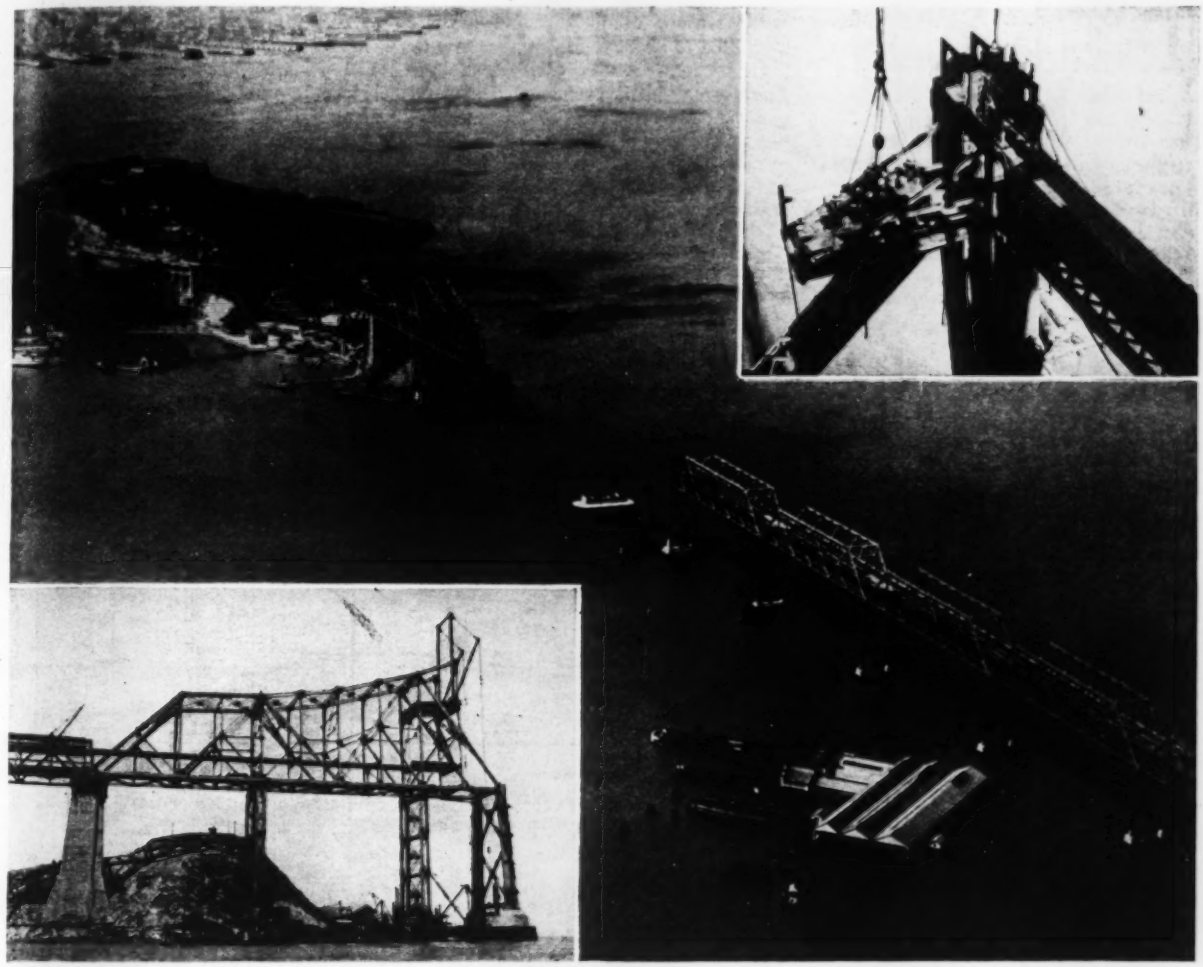
Engineering valuation

Since about 1921 the station has had in progress studies relating to various methods of determining average life and probable life of many types of utility

and industrial property units. Statistical methods are being used by which survivor curves are constructed in much the same manner that life insurance companies construct human mortality curves.

Three general studies are being developed: (1) a summary of more than 175 property groups and corresponding curves from which eighteen typical survivor curves have been developed. The type curves are being used to determine average life from stub-survivor curves or curves that are uncompleted because some units of the group are yet in service; (2) a study of the condition per cent of physical property groups and individual units based upon the present worth method of determining value; and (3) method of depreciation accounting for results of the survivor curve and condition per cent studies.

LARGEST CANTILEVER BRIDGE IN THE UNITED STATES TAKES SHAPE AT SAN FRANCISCO



PRACTICALLY UNHERALDED and unsung in comparison with the twin suspension bridges of the West Bay Crossing of the San Francisco-Oakland Bridge, the cantilever bridge in the East Bay Crossing is rapidly taking shape. Quite in its own right, regardless of its place as a unit in what is probably the greatest bridging operation in history, the East Bay cantilever is a noteworthy structure.

● Its main span of 1,400 ft. will make it the longest cantilever bridge in the United States, 200 ft. longer than the Longview highway bridge over the Columbia River. Its steel tonnage of 20,900 will make it the heaviest U. S. cantilever. Its deck, accommodating six lanes of vehicles on an upper level and three lanes of vehicles and two rapid-transit tracks on a lower lever, will give it a greater weight capacity than any cantilever in the United States and a greater transportation capacity than the only two cantilever bridges that exceed it in size—the Quebec Bridge in Canada and the Forth Bridge in Scotland.

● The general view above shows the East Bay cantilever in its present stage of construction with the west 500-ft. anchor span adjacent to Yerba Buena Island and the west cantilever arm of the main span complete. Preparations are being made to start erection at the east anchor span in the near future. The view at the lower left shows the falsework used to erect the west anchor arm, while the one at the upper right is a close-up of the pinning operation at the junction of the bottom chord of this anchor arm and the steel bent on the main pier; a 24-in. pin is being driven by a ram suspended from a derrick line. The bridge is being erected by guy derricks and, partly as a result of their light weight, cantilever erection will be carried through the suspended span to closure at the center; on such other large cantilever bridges as Carquinez Straits in California, Quebec and Forth the suspended spans have been floated into position and hoisted into place.

● In view of the place of the East Bay cantilever as the largest in the United States and the third largest in the world, comparisons with the Quebec and Forth bridges are natural. Span lengths of the East Bay, Forth and Quebec bridges are respectively 1,400, 1,700 and 1,800 ft.; steel tonnages are 20,900, 30,000 (for a comparable portion) and 62,900; widths c. to c. of trusses are 66, 34 to 120 (widest at the piers), and 88 ft.; clearances above water are 185, 150 and 150 ft. With respect to materials used, the comparison is unusually interesting, emphasizing the growing use of alloy steels. The Forth Bridge of 1890 used what would now be commonly known as a medium or possibly a hard carbon steel. In the Quebec Bridge 27 per cent is nickel steel and 73 per cent carbon steel. In the East Bay cantilever, 16 per cent is nickel steel, 40 per cent silicon steel, and 34 per cent carbon steel; the remaining 10 per cent is composed of heat-treated eyebars.

● The Columbia Steel Co. has the general contract for the superstructure of the East Bay cantilever. The steel is being furnished and erected by the American Bridge Co. For the Bridge Authority, C. H. Purcell is chief engineer, Chas. E. Andrew, bridge engineer, and Glenn B. Woodruff, engineer of design.

Engineering in Foreign Countries

Accounts taken from the foreign-language periodicals of important activities in engineering research, design and construction being carried on beyond the United States

TO GIVE the readers of *Engineering News-Record* quick glimpses of engineering activities beyond the United States, these short abstracts of articles and papers published in languages other than English are presented monthly. In these abstracts no attempt is made at a compendium of foreign-language articles, but selection is made from articles that emphasize some procedure or invention in engineering practice that has general interest or usefulness.

Previous groups of these abstracts from foreign periodicals have been published in *Engineering News-Record* of Jan. 31, Feb. 21, March 28, April 25, May 30, July 4, July 25 and Sept. 5, 1935.

Vagaries of the Leaning Tower of Pisa

According to G. Girometti, writing in *Annali dei Lavori Pubblici* of February, 1935, persistent rumors on the precarious condition of the famous Leaning Tower of Pisa have induced the government of Italy to make a study of its alleged instability.

Records dating back to 1911 have shown the eccentricity of the tower to be increasing at the rate of about one millimeter (0.04 in.) per annum, which for a tower rising about 177 ft. amounts to some 4 sec. of arc. Since 1932 the foundation of the tower has been improved by drainage, waterproofing and grouting. More than 1,000 tons of high-strength cement were injected, in the form of grout, through 361 diamond-drill holes, about 2 in. in diameter, totaling 4,600 lin.ft.

Instruments of the highest precision, levels, seismographs and a special pendulum inclinometer have been installed to measure the subsequent deviations of the tower. The inclinometer, known as the Girometti-Bonechi inclinometer, records angular variations photographically to within 1/75 sec. of arc. A most interesting graph of daily inclinometer records, extending from Sept. 1, 1934, to April 30, 1935, is reproduced in Fig. 1. The graph shows that during the half year from September, 1934, to February, 1935, the amplitude of the north-to-south oscillation of the tower amounted to about 8 sec. of arc. While the north-to-south oscillations apparently exhibit a cyclic and recuperative tendency, the west-to-east oscillations seem to be persisting and cumulative in one direction—eastward—and by the end of April, 1935, the total deviation amounted to nearly 6 sec., which may indicate an annual rate of 9 sec., or over 2 mm. (0.08 in.) increase in eccentricity.

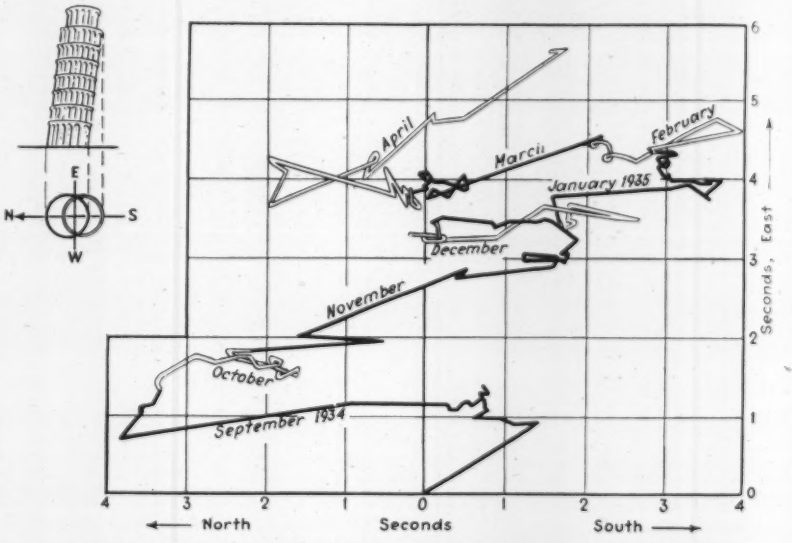


FIG. 1—OSCILLATIONS of Leaning Tower of Pisa, from Sept. 1, 1934, to April 30, 1935, as recorded by Girometti-Bonechi inclinometer.

The Belgrade suspension bridge

The most important modern highway bridge of Yugoslavia, the King Alexander I suspension bridge over the Save River between Belgrade and Zemun, was opened to traffic on Dec. 16, 1934. The design and construction of this bridge are discussed by K. Nowak in *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines* of Aug. 9, 1935, and by F. Bohny in *Der Bauingenieur* of May 24, 1935.

As seen on Fig. 2, the bridge, having a main span of 856 ft. and a total length of 1,348 ft., is flanked on the Zemun shore by a reinforced-concrete viaduct 733 ft. long and an earthfill ramp 394 ft. long. The bridge carries two stiffening double-plate girders 14 ft. deep, spaced 47.6 ft. apart. With two sidewalks supported on cantilevers, each 12.1 ft. wide, the total width of the bridge is practically 72 ft. The towers rise 115 ft. above the piers, whose height, from bedrock, measures 105 ft. (Belgrade side) and 129 ft. (Zemun side). The cables sag 92 ft., which gives the bridge a sag ratio of 1:9.3.

The bridge is of the self-anchored type. Each of the 37 2½-in. strands of the cables is individually connected to the ends of the stiffening girders, whose dimensions had to be locally enlarged for the purpose. To reduce the triple indeterminancy of the self-anchored suspension bridge, hinges were introduced in the stiffening girders, one near each tower, at the points marked G_1 and G_2 (Fig. 2). Thus the structure becomes singly indeterminate when loaded and completely determinate when carrying no traffic. Erection stresses due to static indeterminancy were re-

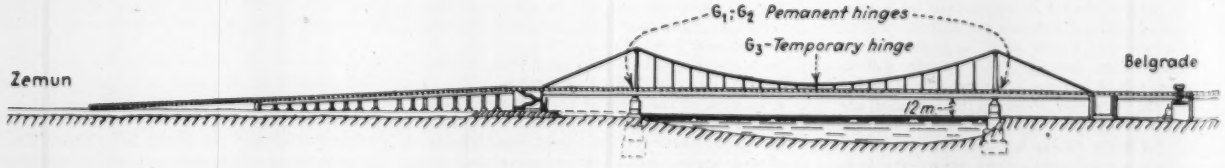


FIG. 2 — SELF-ANCHORED suspension bridge recently opened in Belgrade, Yugoslavia.

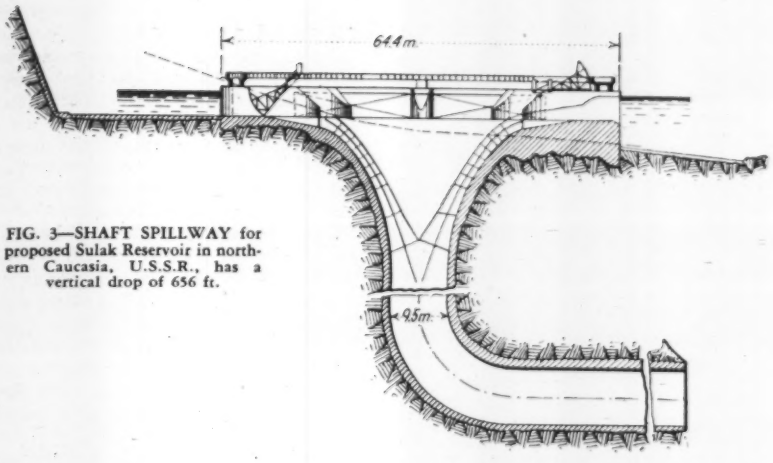


FIG. 3—SHAFT SPILLWAY for proposed Sulak Reservoir in northern Caucasia, U.S.S.R., has a vertical drop of 656 ft.

lieved by means of a temporary hinge introduced at the middle of the main span (point G_3, Fig. 2), which was subsequently eliminated by riveted butt strapping.

The cables, which are hexagonal in section and 26 in. in diameter, consist of 37 strands 2.6 in. in diameter, each strand containing 185 wires. Tests have shown that a strand is good for 393.5 tons which, for a computed maximum stress in the backstays equal to 157.3 tons per strand, gives the cable a factor of safety of about 2.5.

The bridge passed an elaborate series of tests made by a staff of Swiss experts. The test loading consisted of ten motor trucks, weighing 9 to 11 tons, and a troop of 700 mounted cavalrymen.

Tests of shaft spillway models

One of the most interesting structures of the proposed Sulak River hydroelectric power development, at Cherkay, Northern Caucasia, will be a shaft spillway of 60,000 cu.ft. per sec. capacity, having a vertical drop of 656 ft. (The dam proposed for this development is said to be higher than Boulder Dam in this country.) As shown on Fig. 3, the outside diameter of the shaft funnel will be about 211 ft., the inside diameter of the shaft proper about 31 ft. The diameter of the horizontal wasteway tunnel, 2,510 ft. long, will be 36 ft. or 11 m., not 9.5 meters, as indicated on the drawing.

The crest of the tunnel, which is flat, is provided with twelve dividing piers and with tainter gates. The charging head at the crest will ultimately be about 13 ft.

The results of the tests of a 1:75 model of this spillway have been published by Prof. A. N. Akhutin in *Hydrotechnicheskoye Stroitelstvo* of April, 1935. The tests showed the following facts:

1. The weir discharge coefficient of the flat funnel crest was not 2.5 (using a weir formula of the type: $Q = CLH^{3/2}$) as was assumed, but nearly 2.9,— and that this coefficient remained practically constant up to the stage when the funnel became flooded and the discharge varied from 123 to 171 per cent of the 60,000 cu.ft. per sec. for which the spillway was designed.

2. The depth of the nappe on the flat zone of the bellmouth of the funnel varied from 85 per cent of the charging head (13 ft.) at the outside edge to 65 per cent at the inside edge.

3. Negative vacuum pressures appear near the lower end of the funnel and disappear at about ¾ of the total depth of the shaft where the shaft begins to run full. Introduction of air through inlets bored at various levels of the shaft model greatly reduces the vacuum, as shown in the accompanying table, and practically eliminates dangerous violent vibrations and rumbling due to sudden eruptions of air passes through the funnel.

No. air inlets	0	2	4	8	12	16	24	32
Total area inlets in % of shaft cross-section	0	3.4	6.75	13.5	20.25	27	40.5	54
Vacuum in mm.	275	195	130	90	85	110	85	71

But at the same time the discharging capacity of the shaft decreases thus:

No. Air Inlets	Discharge Cu. Ft./Sec.	Per Cent Max. Discharge
0	103,000	100
2	88,000	85.5
4	83,000	81
8	79,500	77.4
16	77,800	76
24	76,000	74

It was therefore decided to allow only eight air inlets, having a total area of 13.5 per cent of the cross-section of the shaft. With eight air inlets the shaft may be expected to discharge 32 per cent more than the required 60,000 cu.ft. per sec.

4. The horizontal tunnel wasteway was found to run about 60 per cent full, with stream velocities ranging from 75 to 98 ft. per second. Only at flows exceeding the required capacity by 25 per cent or more did it run full, with a pressure head of about 150 to 160 ft.

Additional tests of a 1:40 model of a smaller-shaft spillway, for the Sion Reservoir (capacity 10,600 cu.ft. per sec., vertical drop 210 ft.) emphasized the necessity of training walls and dividing piers, for without these the nappe became a turbulent vortex and the discharge dropped to 35 per cent of the required capacity.

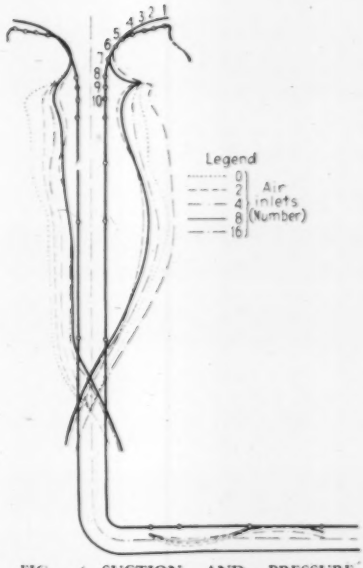


FIG. 4—SUCTION AND PRESSURE within model of Sulak Reservoir shaft spillway.

When the model was later redesigned along the lines of our Owyhee shaft spillway in Oregon, its performance became satisfactory, and its capacity increased to 14,400 ft. per sec., corresponding to a weir-discharge coefficient of 3.75. Still, in the absence of a proper training wall, a vortex may form and the weir-discharge coefficient may drop to 1.8.

Connecticut Photographic Map

An air view of the entire state of Connecticut has been made possible by a large photographic wall map, probably the first to include a complete state. The map was prepared by Fairchild Aerial Surveys and displayed at the Tercentenary Industrial Exhibition at Hartford, Conn., Oct. 2 to 12.

The complete picture measures 18x13 ft., and the 5,004 sq.mi. of territory within the boundary of the state are shown at a scale of 1 mile to 2 in. The picture is made up of 34 large composite prints made from 10,479 exposures taken by the Fairchild Aerial Surveys this spring. The exposures, which cover approximately 3½ sq.mi. at a scale of 1 in. to 1,200 ft., were taken at an altitude of about 11,400 ft.

The complete set of aerial photographs was delivered to the state highway department in 34 sections, each measuring 5x8 ft. at a scale of 1 in. to 1,200 ft. Each section was rephotographed and reduced and then assembled into the complete map.

Federal Housing Program Shifts to a New Base

President's recent division of work-relief funds between PWA and WPA gives Housing Division $120,000,000, which it has divided among 44 projects in 31 cities

WHEN President Roosevelt decided on Sept. 15 that most of the unallotted relief-works fund balance of $1,250,000,000 should go to WPA, the plans of the PWA Housing Division for a $240,000,000 low-cost housing program went into the discard. The President intimated that a $100,000,000 program for housing would be ample, in view of the necessary completion of all projects by January, 1937. Rapid shuffling of available projects by Housing Division officials has now resulted in a definite plan for spending $120,365,000 on 44 projects in 31 cities and one project in the Virgin Islands.

Third change in program

This shift in base is the third made so far in the large-scale low-cost housing program since it was inaugurated in July, 1933, with an operating allotment of $150,000,000. The current relief-works bill boosted this total by earmarking $450,000,000 for housing. Then this was reduced to $240,000,000 in the light of available acceptable projects. Now the total is again reduced to $120,000,000.

Accompanying this article is a tabulation of the projects of the current program, giving their size and type, the architects and contractors (where selected) and the present status of planning or construction. The table includes all but the Virgin Islands project, which is estimated to cost $250,000 and has not been definitely located. All projects previously announced but not listed are indefinitely suspended. It will be noted that the total allotments as given by the table are $118,765,000 or $1,600,000 less than the figure announced by the Housing Division. The $250,000 for the Virgin Islands does not make up the difference.

Nearly 25,000 fireproof living units are provided in this federal demonstration program of slum-clearance and low-rent housing. On 23 of the 44 sites, the new housing will replace slums with living quarters embodying certain basic standards such as hot and cold running water, cross-ventilation, adequate light, cooking and refrigerating facilities. The fireproof nature of the construction is exemplified by the project farthest along toward completion "Techwood" in Atlanta, Ga. (*ENR*, July 7, 1935, p. 7).

Twenty projects will be erected on vacant land and one on land partly slum and partly vacant. The vacant sites were selected pending final determination by the courts of the federal government's right to condemn slum-occupied land for clearance and the construction of new housing.

The allotments include a 45 per cent grant. The rentals are planned to repay the balance to the federal government over a 60-year period of amortization. Rents, it is announced, will be determined by the final cost of the projects, each development being planned "to keep charges commensurate with those now being paid for substandard shelter."

Separate foundation contracts

In order to push the program to completion by January, 1937, the Housing Division is drawing plans for foundations, and will call for separate bids on this work. Foundation plans are well advanced on several projects, and the first advertisements for bids will appear soon. This method of expediting the program was adopted because of the impossiblity of pushing all projects to completion in so short a time if commencement of construction in every instance had to wait on drafting complete plans and specifications and advertisement of a general contract.

The bids of George A. Fuller Co., Washington, D. C., on the Outhwaite project, Cleveland, Ohio, for $2,569,975, and of the Madsen Construction Co., Minneapolis of $3,001,000 for the Cleveland West Side project were accepted by the Housing Division Oct. 14.

SCOREBOARD OF LARGE-SCALE LOW-COST FEDERAL (PWA) HOUSING AS OF OCT. 15, 1935

Name of Development	Amount of Allotment	Area		No. of Family Units	Type of Structure	Architects	Contractors	Present Status
		Total Acres	% Building Coverage					
Atlanta, Ga. "Techwood"	$2,875,000	24.8	19.5	604	3-sty. dormitory bldgs., 2- and 3-sty. apts.	Burge & Stevens, Atlanta, Ga.	J. A. Jones Const. Co., Charlotte, N.C.	Const. began 2/12/35 62 per cent complete
Atlanta, Ga. "University"	2,500,000	19	25.0	675	2- and 3-sty. flats and row houses	Edwards & Sayward, Atlanta, Ga.	N. P. Severin Co., Chicago, Ill.	Const. began 4/23/35 9 per cent complete
Atlantic City, N. J. "Site A"	1,700,000	8	24.5	337	2-sty. flats and row houses	J. V. Mathis, chairman,[1] Atlantic City, N. J.		Site acquired, demolition begun 9/19/35
Birmingham, Ala. "Smithfield Court"	2,500,000	28	22.5	712	1- and 2-sty. row houses, 3-sty. apts.	D. O. Willdin, chairman, Birmingham, Ala.		Site under option
Boston, Mass. "Old Harbor Village"	6,000,000	30	23.8	1046	3-sty. walkup apts., 1 and 2-sty. row houses	J. D. Leland, chairman[1], Boston, Mass.		Bids for foundations advertised 10/14/35
Buffalo, N. Y. "Lang Field"	4,500,000	65	11.8	893	1-and 2-sty. row houses and flats	C. Oakley, chairman, Buffalo, N. Y.		Site under option
Cambridge, Mass. "Main Street"	2,500,000	7	25.0†	579	2-sty. row houses and flats and 3-sty. apts.			Site under option
Camden, N. J. "Westfield"	3,000,000	25	17.2	595	2-sty. row houses and flats and 3-sty. apts.	J. N. Hettel, chairman, Camden, N. J		Site under option
Charleston, S. C. "Meeting Street"	1,150,000	22	14.6	291	1- and 2-sty. row houses	S. Lapham, chairman Charleston, S. C.		Site under option
Chicago, Ill. "Jane Addams Houses"	1,500,000	6	32.0	304	2-sty. row hs., 3-sty. apts.	John A. Holabird, chairman, Chicago, Ill.		Site acquired

[1]In some cities projects are handled by a group of architectural firms, with one architect acting as chairman.
†Approximate, pending completion of architectural plans.

SCOREBOARD OF LARGE-SCALE LOW-COST FEDERAL (PWA) HOUSING AS OF OCT. 15, 1935—Continued

Name of Development	Amount of Allotment	Area		No. of Family Units	Type of Structure	Architects	Contractors	Present Status
		Total Acres	% Building Coverage					
Chicago, Ill. "Trumbull Park"	$3,250,000	22	20.0†	550	2-sty. row hs., 3-sty. apts.			Site under option
Chicago, Ill. "Diversey"	6,000,000	38	21.0	1,042	2-sty. row hs., 3-sty. apts.	Robert DeGolyer, chairman, Chicago, Ill.		Site acquired
Cincinnati, Ohio "Basin Housing"	6,500,000	24	22.0	1,278	3- and 4-sty. apts.	Frederick W. Garber, chairman, Cincinnati, Ohio		Site being purchased
Cleveland, Ohio "Cedar-Central"	3,279,000	18.2	21.0	654	3-sty. fireproof walkup apts. and basements	Walter McCornack, Cleveland, Ohio	Geo. A. Fuller Co., Washington, D. C.	5 per cent complete
Cleveland, Ohio "Outhwaite"	3,650,000	20.6	28.7	885	2- and 3-sty. apts. and row houses	Maier, Walsh & Barrett, Cleveland, Ohio	Geo. A. Fuller Co., Washington, D. C.	Contract let 10/10/35
Cleveland, Ohio "West Side"	3,800,000	22.1	20.2	635	3-story apts. and 2-sty. row houses	J. L. Weinberg, Cleveland, Ohio	Madsen Const. Co., Minneapolis, Minn.	Contract let 10/14/35
Columbia, S. C. "University Terrace"	500,000	4	26.0	162	1-and 2-sty. row houses and flats	J. B. Urquhart, chairman, Columbia, S. C.		Bids for demolition advertised 10/14/35
Dallas, Tex. "Lucas Drive"	900,000	17	15.9	215	1- and 2 sty. row houses	W.C. Sharp, chairman, Dallas, Tex.		Site acquired
Detroit, Mich. "Chandler Park"	4,500,000	31	20.0†	893	3-sty. apts. and 2 sty. row houses and flats			Site under option
Detroit, Mich. "East Side"	5,500,000	64	21.9	1,032	3-sty. apts. and 2-sty. flats and row houses	George D. Mason, chairman, Detroit, Mich.		Site being assembled
Indianapolis, Ind. "Community Hsg."	3,025,000	22.1	27.3	1,044	2- and 3-sty. apts., 2-sty. row houses	Russ & Harrison, Indianapolis, Ind.	N. P. Severin, Co., Chicago, Ill.	1 per cent complete
Jacksonville, Fla. "Durkeeville"	1,000,000	20	13.3	253	1-and 2-sty. row houses	M. C. Greeley, chairman, Jacksonville, Fla.		Site under option
Lexington, Ky. "Blue Grass Park"	1,500,000	67	6.3	350	1- and 2-sty. row houses and flats	H. Meriwether, chairman, Lexington, Ky.		Site acquired
Louisville, Ky. "H-2501"	1,618,000	11.1	25.0	460	2- and 3-sty. fireproof apts.	E. T. Hutchings, Louisville, Ky.		Appeal to U. S. Supreme Court on legality of condemnation pending
Louisville, Ky. "Dixie Highway"	1,200,000	14	20.0†	278	1- and 2-sty. row houses	E. T. Hutchings, chairman, Louisville, Ky.		Site acquired
Louisville, Ky. "Florence Place"	700,000	5	25.0†	125	1- and 2-sty. row houses	E. T. Hutchings, chairman, Louisville, Ky.		Site acquired
Memphis, Tenn. "H-3401"	3,200,000	39	17.0	635	1- and 2-sty. row houses and 2 sty. apts.	J. F. Smith, chairman, Memphis, Tenn.		Site under option
Memphis, Tenn. "H-3403"	3,000,000	25	18.0†	694	1-and 2-sty. row houses and 2-sty. apts.	J. F. Smith, chairman, Memphis, Tenn.		Site under option
Miami, Fla. "Sixty-Second St."	1,000,000	60	8.0	255	1-sty. row houses	Paist and Steward, Miami, Fla.		Site under option
Milwaukee, Wis. "Parklawn"	2,800,000	42	13.0	458	2-sty. row hs. and flats, 3-sty. apts.	G. J. DeGelleke, chairman, Milwaukee, Wis.		Bids opened 10/15/35
Minneapolis, Minn. "Summer Field"	3,500,000	26	20.0	694	2- and 3-sty. apts. and row houses	W. H. Tusler, chairman, Minneapolis, Minn.		Site being purchased
Montgomery, Ala. "Thurman St."	459,000	7	22.7	158	1- and 2-sty. row houses	Carl B. Cooper and Moreland G. Smith, Montgomery, Ala.	T. L. James & Co., Ruston, La.	9 per cent complete
Montgomery, Ala. "Bell St."	416,000	13.8	8.5	100	1- and 2-sty. row houses	Ausfeld & Jones, Montgomery, Ala.	T. L. James & Co., Ruston, La.	Contract awarded 9/24/35
Nashville, Tenn. "H-2101"	1,700,000	19.7	15.0	276	1- and 2-sty. row houses	Richard R. Clark, chairman, Nashville, Tenn.		Site acquired
Nashville, Tenn. "Sixteenth Ave."	1,500,000	22	20.0	361	1- and 2-sty. row hs. and 2-sty. flats	R. R. Clark, chairman, Nashville, Tenn.		Bids for demolition opened 10/17/35
New York, N. Y. "Williamsburg"	12,783,000	21	33.0	2,029	4-sty. walkup apt.	R. H. Shreve, chairman, New York City		Site being purchased
New York, N. Y. "Harlem-McCombs"	4,700,000	8	34.5	725	4-sty. walkup apts.	A. M. Brown, chairman, New York City		Site under New York City condemnation
Oklahoma City "H-8101"	2,000,000	18	12.5	539	1- and 2-sty. row houses	J. O. Parr, Oklahoma City, Okla.		Site acquired
Omaha, Neb. "North Side"	2,000,000	15	23.6	483	1- and 2-sty. flats	W. L. Steel, chairman, Omaha, Neb.		Site under option
Philadelphia, Pa. "Hill Creek Park"	1,800,000	24	14.0	340	1- and 2-sty. row hs., 2-sty. flats and 3-sty. apts.	W. H. Thomas, chairman, Philadelphia, Pa.		Site under option
Stamford, Conn. "Fairfield Ave."	800,000	5	20.0†	165	1- and 2-sty. row hs., 3-sty. apts.	W. J. Provoost, chairman, Stamford, Conn.		Site under option
Washington, D. C. "Langston Terrace"	1,600,000	13	21.1	322	2-sty. flats and row hs. and 3-sty. apts.	Robinson, Porter, and Williams, Wash., D.C.		Site acquired
Washington, D. C. "Anacostia Terrace"	60,000		17.5					Site acquired
Wayne, Pa. "Higland Avenue"	300,000	2	20.4	62	2-sty. flats and row houses	H. B. Register, chairman, Wayne, Pa.		Site under option
Totals	$118,765,000	995.		24,444				

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October 17, 1935

What Next?

CONTRACTORS bidding on public works these days are prepared to meet all manner of labor and wage requirements, but a clause in the specifications for the proposed Illinois River lock near Peoria leaves them gasping in astonishment. On this project the contractor must not only use relief labor in the prosecution of normal construction operations, but he must also take this green labor to the woods and to the pits to obtain directly all the piles, timber, concrete aggregates and riprap needed to build a 110x600-ft. lock. If the items involved were of small quantity, the requirement would not seem so fantastic. However, some 7,000 trees must be cut and trimmed for piles 30 to 35 ft. long, and a quarter million feet of cribbing timber must be cut from standing trees; sand and gravel for 65,000 cu.yd. of concrete must be dug from the pits, and 6,000 cu.yd. of stone must be quarried for riprap. An interpretation that the contractor may sublet the production of these materials to commercial producers is of scant help, for relief labor must be used regardless of who supplies the commodities. If he has to go far afield, which is certain for the timber and highly probable for the piling, he may use local relief labor, to be paid at the Peoria scale of wages. Thus, in the desperate attempt to meet the arbitrary man-hour requirements set up by administrative rulings for the works program, the army engineers have now gone far beyond the disruption of field construction practice and have invaded the materials-producing industries. Is it possible that before long we will see the cement, steel, pipe and other commodities for public works also produced by relief labor?

In Critical Condition

FOR A NUMBER OF YEARS Seattle has been notorious for its contemptuous treatment of those whom it called to serve it in the capacity of city engineer. Arbitrary dismissals without explanation, and quite without a shadow of evidence that the incumbent was lacking in competence or efficiency, revealed how thoroughly the office had become the plaything of politics. The disgraceful record is now climaxed by the astounding proposal to abolish the city engineer's office altogether and assign its duties to the superintendent of streets. Whether the proposal is born of sheer ignorance of what adequate city engineering service requires, or whether there are sinister motives back of a policy so contrary to the best interests of a large and growing city, remain obscure; but there can be no question about the destructive effect upon the city that would follow actual adoption of the proposal. A year ago we spoke briefly of the evil conditions that surrounded Seattle's official attitude toward its city engineering services, and under the title of "Creeping Paralysis" (*ENR*, July 12, 1934, p. 56) pointed out the dangers confronting the city's progress. Current developments, as reported in the news pages of this issue, suggest that the warning of last year contained a prophetic element: The new proposal gives reason to fear that the paralysis is indeed of virile type. The citizens of Seattle who are concerned about the city's future have a challenge confronting them in the proposal to abolish the office of city engineer. If they can unite in framing and then supporting a charter amendment that would establish the office of the city engineer and keep it out of politics, a fatal result may yet be averted.

Forty-four Opportunities

THE LOW-COST HOUSING PROGRAM of the PWA has finally settled down, albeit by a series of nasty jolts, into a plan for spending a definite amount of money on a definite number of projects. The money is $120,000,000 and the projects total 44 in 31 cities. But although the program may be definite, its purpose has become somewhat obscure. Since two of the three initial objectives—business stimulation and large-scale clearance of slum areas—no longer apply, there is left the objective of "demonstrating" to the cities what is possible in large-scale low-cost housing. This, it may be conceded, is a purpose that needs no apology, but it is also one that places a considerable responsibility on the PWA Housing Division, which will not only build but operate the projects. For example, city officials and real-estate interests, including financial institutions, all of whom are harassed by the problem of blighted areas, need to have demonstrated that slum clearance is not only a social but an economic asset; 24 of the 44 projects involve slum clearance and provide this demonstration opportunity. Everyone interested in large-scale rehousing needs to know if fire-safe living quarters can be provided at a sufficiently low cost to help the lower-income groups. Further, it is required to know how many, if indeed any, of the so-called modern conveniences can be furnished in low-cost housing; how much of the 45 per cent subsidy provided is required to make the housing low-cost in fact as well as in name; and how people take to living in government-owned housing. The PWA housing program offers 44 rare opportunities to spend federal funds constructively. Sooner or later every community in the country must face the question of a more social approach to the housing problem. Facts, guidance and perhaps encouragement in this difficult task can be furnished by the PWA if it is able to grasp its opportunities and discharge its responsibilities.

Work Worthy of Support

THREE YEARS' LABOR of the Engineers' Council for Professional Development confirms the belief that nothing develops cooperation like cooperation. The Council's meeting a week ago showed steady progress toward sympathetic understanding of objectives and proved that the obstacles yet to be overcome in developing a stronger professional structure by joint action are seen more clearly and faced more resolutely. The strengthening of college courses through the influence of a unified accrediting system, which is just being initiated, will in turn strengthen the standards of society recognition. It may also be expected to bring into clearer view than heretofore the need for technical education of intermediate grade as well as the possibility of definite training directed toward development of initiative. The broad purposes of the Council, which look

toward a stronger professional body of higher competence, broadened fundamental training and great incentive to individual progress clearly invite the active support of the whole profession. On the basis of the Council's accomplishments up to the present the support is well merited.

A Mark of Distinction

BY DROPPING its certification plan the Engineers' Council for Professional Development has eliminated one of the obstacles to its continued progress and has made probable the continued adherence of the National Council of State Boards of Engineering Examiners and the cooperation of the state professional societies, which is highly desirable. Nominally, the certification plan has only been shelved temporarily by referring it back to committee for further consideration; but it is obvious from the character of the action taken, as reported in our news pages, that the present certification plan has been dropped. With this disturbing proposal out of the way attention can be focused on the more important elements of the Council's program—vocational guidance and orientation, improving and broadening the scope of engineering instruction, and laying down programs of study for the young engineer in the years following graduation. After these proposals have taken concrete form there will be ample time to consider whether and in what form the E.C.P.D. should issue a certificate to record the fact that its holder has attained what it believes to be the status of a well-rounded engineer. That certificate, we hold, should be a mark of distinction, not evidence that the holder has the minimum requirements for registration by state examining boards or for entrance into the engineering societies, as was proposed in the program now discarded.

Impossible Contracts

WHEN the great Blackstone defined a contract as "An agreement upon consideration to do or not to do a certain thing," he scarcely expressed the full measure of meaning of a contract as it is now regarded in law. There the meaning carries the element of compulsion to perform or to submit to penalty for failure. It is this more completely stated interpretation that the construction contractor should never forget and that he too often disregards.

In part the attitude of the contractor has been inspired by the more lenient judgment of the contract obligation by the courts as time has gone on. The old decisions that sternly required the losing party of a contract agreement to render up his pound of flesh even if it involved his destruction are no longer in force as valid precedents. New and more charitable consideration is given to impossibilities of contract performance, as is set forth by an article in this issue. But this is far from meaning that the law today esteems a contract lightly. The case decisions quoted by Mr. Young have made this fact impressively clear to many contractors.

The serious obligation of a construction contract cannot safely be overlooked. By and large, construction contractors have always been heedless of this truth. Emphasis on the unwisdom of such negligence is particularly pertinent at the present time when strange wage and labor conditions are being imposed and when contractors long denied work have a disposition to be reckless of hazards.

The contractor even more than the agency that contracts with him for the work depends on definite terms of agreement for his estimates of cost and his correct appraisal of the performance demanded. The courts have done much in recent years to relieve the contractor of penalties where there has not been a true meeting of minds in the contract agreement, but they keep a jealous eye on unwarranted violation of its sanctity. Judicial decisions draw a heavy line between contracts impossible to perform and those whose failure is due to incapacity to meet the obligations agreed upon.

Mastery Through Understanding

JUST as every complex operation is made up of simple elements, so all phases of engineering consist of elementary facts and relations. Much of the engineer's skill lies in his grasp of these elements and his ability to recognize them in the particular problem with which he may be dealing. Nowhere is this truer than in the field of structures. Here the engineer's success at all times depends on how intimately he understands elementary physical facts and behavior.

Complexities of refined method applied to structural problems tend to befog the simply physical aspect of many problems. Often, indeed, a clear view of the conditions at hand and the result to be attained is rendered impossible by the bewildering effect of elaborate procedure or involved method. It is for this reason that the power to see each problem in terms of the simplest structural elements and forms is of primary importance to the engineer.

For that large number of structural engineers who have struggled and floundered in a welter of intricate methods of stress analysis, for example, the healthy philosophy recorded by Professor Cross in his article in this issue will prove gratifying and illuminating. It will help the engineer in two directions: first, recognizing in the particular structure before him the elementary forms to which his structural sense has long before been adjusted; and second, unraveling the maze of special methods of analysis and understanding them in terms of their elementary meaning regardless of name and of analytical elaboration.

Professor Cross' philosophy, because it is fundamental, has application far outside the range which he discusses. It can be helpful in dynamics as well as statics; it can serve the hydraulic engineer and the construction man. Its essence is the division of a structure, an operation or a problem into its simplest component units, and recognition of the relations between these units in terms of simple actions and facts.

During recent decades structural practice has grown greatly in variety of type and complexity of method. In practice, however, types and relations are not always what they seem on the design sheets, and grave error may result if the engineer thinks of type forms alone without verifying the physical nature of his structure. Only by constant care to see the structure in the simplest form that the physical conditions and actions determine, and to shape his design in harmony with an understanding of its actual behavior, can he attain mastery of his art.

CURRENT NEWS

Florida Canal Excavation Bids Average 21.7c. Per Cu.Yd.

Eight contractors bid an average of 21.7c. per cu.yd. for 25 sections, aggregating 13,435,000 cu.yd. of excavation, for the Atlantic-Gulf canal in Florida, according to a tabulation of apparent low bidders announced by the Army Engineers at Ocala, Fla. Bids were opened on Oct. 7 for 28 sections of the canal involving 18,000,000 cu.yd.; the low bidder on three of the sections has not been announced. No formal contracts have been awarded. Bidders were allowed to submit prices on any, all, or on any combination of sections. Two sets of bids were asked for, one on basic quantities involving the full-section prism of the canal; the alternates considering only part excavation of the full prism. In the engineer's announcement five of the 25 sections were listed as alternates, indicating that only part of the excavation will be done on these sections at present. Bids ranged from a low of 19c. per yd. to a high of 24c.

Firms listed as low are: Lewis Chambers Const. Co., New Orleans; Hooper Const. Co., Bunnell, Fla.; Badgett Const. Co., Memphis, Tenn.; Blythe Bros. & Boyle Road and Bridge Co. & C. G. Fuller, Barnwell, S. C.; The Geo. T. Auchter Co., Jacksonville, Fla.; Harvey-Ray & Noonan, Pensacola, Fla.; Geo. S. Funk & Stevenson Co., Clarksdale, Miss.; and Benjamin Foster Co., Philadelphia, Pa. The bidders guaranteed to provide at least 1,500 man-hours of labor for each $1,000 of contract.

Court Holds Wage Rates May Be Set by Secretary of Labor

Legality of the Bacon-Davis Act of 1931 empowering the Secretary of Labor to determine the prevailing wage rates applicable to federal building projects in case of dispute was upheld Oct. 8 by the U. S. Circuit Court of Appeals at Richmond, Va. The court held, however, that the law does not confer authority on the Secretary to fix the date on which the rates so determined take effect.

Reversing the decision of the district court in eastern South Carolina in the case of the United States, for the use of J. H. Wylie and others, vs. W. S. Barstow & Co., Inc., the circuit court held that laborers employed on construction of the veterans' hospital at Columbia, S. C., were entitled to receive the wage rate determined by the Secretary from March 3, 1932, until April 1, 1932, as well as thereafter.

The case arose when the Veterans Administration ruled that the prevailing wage applicable to Wylie, a bricklayer employed on the project March 3, 1932, was 65c. an hour, and the Secretary, on appeal by the workers, held the prevailing rate was $1, effective April 1. In reply to other workers who sought to recover for various periods prior to March 3, the court said that the point could be regarded as well taken only if the Secretary's decision covered the status of wages in the earlier periods of work on the project.

Reclamation Bureau Outlines Plans For Central Valley

PLANS announced by Dr. Elwood Mead, Commissioner of Reclamation, for the first year's work on the Central Valley project in California include the Contra Costa conduit and initial construction on both the Friant and Kennett Dams. The Reclamation Bureau discarded its previous plans to build Friant Dam, in conjunction with either the Madera and Friant-Kern Canals or the Contra Costa conduit and a standby steam plant when President Roosevelt reduced the allotment for the California project from $20,000,000 to $15,000,000.

The basis on which the Bureau has decided to go ahead is satisfactory to the state of California, according to Dr. Mead. The Contra Cost conduit, to cost $2,500,000, will comprise a partially useful unit in advance of the completion of the dams and will supply fresh water from the San Joaquin River to the industrial cities on the south side of Suisun Bay. It is expected that construction will start within sixty days.

Work will commence on Friant Dam on the San Joaquin River as soon as rights of way can be obtained. The project will cost about $14,500,000 and it is probable that the major portion of this year's allotment will be spent on this unit. Initial work on Kennett Dam will include foundations and diversion tunnels. This is the major structure in the Central Valley plan to bring the Sacramento River under control and regulate the flow of surplus water so as to permit diversion into the San Joaquin Valley and will cost upwards of $50,000,000, exclusive of the power plant. This year's expenditure on Kennett Dam probably will amount to $4,000,000 or $5,000,000. Relocating the Southern Pacific R.R. line is regarded as ill-advised until there is assurance that more money will be forthcoming to carry the project forward. Since the Reclamation Bureau is not in a position to guarantee completion of a useful unit, the work on the several units to be undertaken will go forward without repayment contracts. Commissioner Mead does not anticipate any difficulty in negotiating such contracts when the Reclamation Bureau is able to carry the project on to completion.

Headquarters will be centrally located at Sacramento, with Walker R. Young, construction engineer on Boulder Dam, in charge. J. L. Savage, the Bureau's chief designing engineer and L. N. McClellan, chief electrical engineer, are now in California with Mr. Young, drafting final plans for the project. The principal delay at present is lack of rights of way to be provided by the state. In addition to the $15,000,000 allotment from relief works funds, this year's Rivers & Harbors Act carried an authorization of $12,000,000 for flood control that, when appropriated, probably can be applied to the project.

New York Files Brief In Sludge Dumping Charges

The Supreme Court on the first day of its present session, Oct. 7, was asked, in a brief filed by the city of New York, to rule that sludge dumping in the Atlantic Ocean does not violate the order issued in December, 1933, as a result of action brought by New Jersey to prevent the city from dumping garbage at sea. New Jersey maintains that the dumping of chemically treated sludge places New York City in contempt of the order, even though the sludge consists of non-floating solids.

In defending its action, New York City points out that the sludge cannot move from the dumping grounds to the shore and that there is only momentary pollution of the waters at a point ten miles from shore, which is too far out to affect fish-life or bathers. The court has issued a show cause order, returnable Nov. 18, requiring New Jersey to show cause why the petition should not be granted. The city, in its brief, asks that sludge dumping be found not to violate the previous decree, or if so found, that a dumping permit be granted.

Bondholders' Committees To Be Investigated

Operations of committees representing holders of municipal bonds are to be investigated by a Congressional subcommittee of which Representative J. Mark Wilcox of Florida is chairman. It is the purpose of the Congressional committee to develop the full facts concerning the activities of bondholders' committees, some of which have been branded as being perpetrated for the purpose of providing large fees.

Representative Wilcox proposes holding a series of hearings in the South beginning this month, at which bondholders' committeemen and city officials will testify concerning their activities. The success of the investigation will very largely depend he says upon the cooperation which the Congressional committee receives from city officials and public-spirited citizens who are interested in the adjustment of public debts.

For many years defaulted municipalities have been besieged by self-appointed committees. By the establishment of pretentious offices, the engagement of high-salaried clerical forces and the employment of high-priced counsel, in a great number of cases the bondholders receive a small portion of the amounts actually collected by the committees. It also has been pointed out that in quite a number of cases the committeemen themselves receive substantial compensation. It is claimed that frequently the committeemen are not anxious to cooperate with the municipalities in working out an adjustment. On the contrary, long, drawn-out litigation has been resorted to with the result that on numerous occasions refinancing efforts have been successfully blocked by the very committees that were established to work out a settlement.

John C. Page Appointed to New Reclamation Bureau Post

John C. Page, formerly office engineer and second in command at Boulder Dam, has been appointed Chief of the Engineering Division, U. S. Bureau of Reclamation, to succeed George O. Sanford, recently appointed General Supervisor of Operation and Maintenance.

The advancement of Mr. Page brings to a key position in the Washington office a

John C. Page

man who entered the Reclamation Bureau in 1909 as an assistant engineer on the Grand Valley project in Colorado.

Mr. Page was born at Syracuse, Neb., and graduated from the University of Nebraska school of engineering. He entered the Reclamation Bureau shortly after taking post graduate work at Cornell University. From 1909 until 1931 he was connected with the Grand Valley project, serving as superintendent after 1925. In 1931 he was transferred to Boulder City as office assistant. When the Boulder Dam job neared completion early this summer, Mr. Page was transferred to Washington to assist in getting the Bureau's new $81,150,000 works program under way. The new position will keep Mr. Page in Washington.

Master Appointed To Hear Nebraska-Wyoming Dispute

The U. S. Supreme Court, on Oct. 14, appointed Michael J. Doherty of St. Paul, Minn., as special master to take testimony in the suit of the state of Nebraska against the state of Wyoming over the division of the waters of the North Platte River. The court, on April 1, declined to dismiss the action brought by the state of Nebraska requesting an ascertainment of the equitable apportionment between the two states of the waters of the North Platte River and requesting a decree to enforce compliance with the findings. Wyoming had sought to have the action dismissed on several grounds, claiming that the state of Colorado and the Secretary of the Interior should be made parties to the action. The court held at that time that it was not necessary to determine whether or not these were parties to the action (*ENR*, April 4, 1935, p. 501).

Rural Resettlement Administration Announces Suburban Housing Program

(Washington Correspondence)

ESTABLISHMENT of its first "greenbelt" suburban housing development at Beltsville, Md., was announced by the Resettlement Administration this week without disclosing that others will be located at Cincinnati, St. Louis, Oakland and Bound Brook, N. J. The administration's latest attack on the housing problem will cost $31,000,000.

Construction will begin immediately on the Maryland project to provide 1,000 houses for employees of the huge farm research center of the Department of Agriculture which adjoins the new community and for families chosen from other low income groups in Washington and its suburbs.

The Resettlement Administration's plans contemplate a $10,000,000 project at Mt. Healthy, Cincinnati, to provide homes for 1,500 negro families turned out of "the Basin" where PWA Administrator Ickes has undertaken a $6,500,000 slum clearance project. The Resettlement Administration also is planning $5,000,000 projects for St. Louis and Oakland, comprising 1,000 houses each, and also a 500-house development at Bound Brook, N. J., to cost $3,500,000. All projects will be financed with relief works funds.

To take over PWA project

At Hightstown, N. J., the Resettlement Administration has taken over a PWA subsistence homestead project to house New York needle trades workers. The project will include 200 houses built of concrete slabs cast in a plant erected on the site at a cost reported to be 20c. per sq.ft. of wall. One hundred foundations are in on a project originally designed in concrete more than two years ago, then redesigned in wood and later advertised for alternate bids on wood and concrete just before all the PWA's unobligated funds were impounded a year ago to carry direct relief pending enactment of the present $4,000,000,000 relief works appropriation. As plans for the Beltsville, Md., project also call for concrete construction, a battle is brewing between the cement and lumber industries.

Plan and design of projects

For its "greenbelt" developments the Resettlement Administration has designed a community plan to enclose each within a verdant strip to protect it from encroachment and blight. Parks and recreation facilities will be located in this greenbelt. Each community will be designed so that the houses encircle the tract. Automobile traffic will be diverted to the outer rim and a system of underpass walks will make it possible for children to attend school and run errands without crossing streets.

Plans for the Maryland project are drawn to provide ample room for expansion while still enclosing the community within the protective strip. At the adjacent research center, the Resettlement Administration is planning to establish a housing laboratory working in cooperation with the U. S. Bureau of Standards. This laboratory will investigate modern technique and construction methods that presumably will not fully duplicate the research work of FHA's technical division, as both Adminstrator McDonald, of FHA, and Administrator Tugwell are members of the new Central Housing Committee created to pool housing information and avoid conflict among the administration's several housing agencies.

To apply mass production methods

"We are trying to demonstrate a new method to break down the present intolerable situation," said W. W. Alexander, Assistant Administrator, "in which the welfare of one-third of American families is menaced because they live in substandard homes. Past experience has shown that private industry cannot afford to build adequately for the low-income groups nor can these groups, as individuals, build adequately for themselves. If, however, government takes some of the money it spends to correct the results of bad housing, and spends it preventively in erecting good housing, all of us will benefit. And we will at the same time be giving jobs to men in need of them. We buy land outside city limits where prices are relatively low and large tracts can be obtained for planned demonstration communities. This is the first saving. The second and most important means by which we propose to build good homes at low cost is to apply the methods of mass production. The houses in our developments will be assembled with efficiency, economy and speed."

Washington, Oct. 12, 1935.

Frederick Leslie Ransome, Noted Geologist, Dies

Frederick Leslie Ransome, professor of economic geology at California Institute of Technology, died Oct. 6 at his Pasadena home after a long illness. He was 67 at the time of his death.

Dr. Ransome was born at Greenwich, England, in 1868, and was graduated from the University of California in 1893. Joining the staff of Harvard University in 1896, he was assistant professor in mineralogy and petrography for a year, and then became a member of the U. S. Geological Survey. He left the federal service in 1923 to become professor of economic geology at the University of Arizona. In 1927, he accepted a similar position at the California Institute of Technology.

Dr. Ransome was consulting geologist for the United States Bureau of Reclamation and the Metropolitan Water District of Southern California since 1928, and in that capacity carried through a number of important investigations. Among these have been studies of the acidity of the water from the Colorado River and of the river's silting problems. As geologist for the Reclamation Bureau, Dr. Ransome examined and mapped the geological conditions at Boulder Dam and approved the site. In southern California he made numerous geological investigations concerning the safety of existing and proposed dams of the city of Los Angeles and the County Flood Control District.

STATE ALLOTMENTS MADE UNDER PWA PROGRAM

State	Projects receiving grants from relief works funds		Projects receiving loans from PWA revolving fund	
	No.	Amt.	No.	Amt.
Alabama	66	$3,278,092	27	$2,069,000
Arizona	12	355,174	10	348,500
Arkansas	72	3,081,761	70	3,683,580
California	154	35,625,442	43	26,748,514
Colorado	42	5,001,589	14	404,600
Connecticut	60	5,498,347	3	376,530
Delaware	11	576,469	2	87,000
Florida	90	3,890,520	68	4,015,400
Georgia	146	3,284,161	65	841,818
Idaho	28	706,738	21	410,700
Illinois	200	22,453,205	57	9,670,500
Indiana	155	6,651,926	26	1,275,139
Iowa	142	4,688,809	38	615,500
Kansas	78	3,108,595	18	353,500
Kentucky	79	3,951,944	62	4,121,834
Louisiana	0	0	0	0
Maine	18	899,427	10	328,500
Maryland	47	12,116,856	7	335,500
Massachusetts	187	14,465,374	0	.0
Michigan	102	14,981,623	71	15,409,182
Minnesota	118	5,017,407	20	1,432,837
Mississippi	65	2,032,719	58	2,278,147
Missouri	80	6,574,110	25	1,267,016
Montana	16	1,314,607	11	1,363,000
Nebraska	99	(1) 2,150,229	67	(1) 950,200
Nevada	11	514,595	9	937,273
New Hampshire	22	866,995	5	135,336
New Jersey	67	13,224,060	47	13,477,954
New Mexico	20	875,486	13	445,000
New York	203	51,009,249	77	25,761,500
North Carolina	58	3,428,008	40	2,473,188
North Dakota	34	1,426,013	26	1,387,820
Ohio	237	13,611,641	127	6,338,800
Oklahoma	47	4,190,628	15	1,716,600
Oregon	73	(2) 3,029,836	37	1,551,500
Pennsylvania	277	18,912,001	153	8,208,240
Rhode Island	9	3,895,875	0	0
South Carolina	67	(3) 3,196,244	47	(3) 2,585,000
South Dakota	40	1,011,080	34	1,009,200
Tennessee	75	4,645,989	53	4,384,222
Texas	276	19,586,622	186	(4) 7,044,625
Utah	32	1,005,577	16	355,600
Vermont	15	435,400	8	199,319
Virginia	73	3,939,042	20	2,165,000
Washington	112	4,649,441	12	572,000
West Virginia	55	2,232,494	46	2,259,885
Wisconsin	88	5,473,171	11	283,000
Wyoming	9	1,060,099	6	648,250
District of Columbia	2	118,500	1	70,000
Alaska	7	185,915	5	196,500
Hawaii	4	708,565	1	350,000
Virgin Islands	2	111,939	0	0
Total	3,982	(5) $325,049,589	1,788	$162,942,309

(1) Exclusive of grant of $4,500,000 from relief works funds and loan of $5,500,000 from PWA's revolving fund to Central Nebraska Public Power & Irrigation District.

(2) Exclusive of grant of $1,575,000 from relief works funds for new state capital building.

(3) Exclusive of grant of $225,000 from relief works funds and loan of $275,000 from PWA's revolving fund to South Carolina Public Service Authority for preliminary work on Santee-Cooper power and navigation project.

(4) Exclusive of loan from relief works funds of $10,500,000 to Lower Colorado River Authority. This is the only loan made from relief works funds. Loans to other projects are from PWA's revolving fund derived from the sale of securities purchased in financing previous PWA projects.

(5) Total represents 45 per cent grants on construction costing $702,332,420.

Connecticut Prescribes Rates For Dump Truck Haulage

The Connecticut Public Utilities Commission on a petition from the Connecticut Dump Truck Owners' Association has prescribed a schedule of minimum rates and charges for motor contract carriers operating dump trucks for hire. The schedule, which is now effective, applies to hauling all materials except fuel and fuel products. The order states that "Haulage by the hour, including driver; registered capacity, 1½ tons up to but not including 2 tons, $1 an hour; 2 tons up to but not including 2½ tons, $1.25; 2½ tons up to but not including 3½ tons, $2; 3½ tons up to but not including 5 tons, $2.50; 5 tons up to but not including 6½ tons, $2.75; 6½ tons and larger, $3 an hour." Haulage by the ton including the driver: for the first mile of each trip will be 12 cents per ton, and for each succeeding mile, four cents.

Bids Opened for Power House And Fishways at Bonneville

Bids for the construction of the superstructure of the Bonneville Dam powerhouse and fishways were opened in Portland, Ore., Oct. 9. Bids were submitted on three schedules; one schedule was for the power house superstructure, another for the fishways and the third a combination of both.

On schedule No. 3 for the construction of both the powerhouse superstructure and the fishways the General Construction Co., and J. F. Shea, Seattle, Wash., submitted the low bid of $1,160,307.90, and on schedule No. 1 submitted the figure of $768,343.90. Guy F. Atkinson, Portland, Ore., submitted a bid of $1,290,447.20 on schedule No. 3; H. H. Hoffman Construction Co., Portland, Ore., submitted a figure of $780,095 on schedule No. 1. Teufel and Carlson Construction Co., Seattle, Wash., bid $781,763.35 for schedule No. 1.

Certification Plan For the Profession Dropped by E.C.P.D.

THE Engineers Council for Professional Development has dropped for the present its plan for certification in the profession. This action was taken by the council at its third annual meeting held in New York on Oct. 8. The plan was recommended to the participating bodies at the time of the second annual meeting last October. Reports submitted at this year's meeting indicate that the council, organized by the major engineering societies in 1932, is making good progress in the initial work of its program, *i.e.* (1) Develop means for vocational orientation of young men with respect to the responsibilities and opportunities of engineers, (2) Formulate criteria for colleges of engineering, (3) Develop plans for further personal and professional education of young engineers after graduation, and (4) Develop methods whereby those engineers who have met suitable standards may receive corresponding recognition. The bodies represented in the council are the four Founder engineering societies, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education and the National Council of State Boards of Engineering Examiners.

Professional recognition

The certification plan was to have been inaugurated by granting E.C.P.D. certificates to legally registered or licensed engineers and to all corporate members of the four Founder societies and of the American Institute of Chemical Engineers who applied before Jan. 1, 1936. Only four of the participating societies have approved the plan.

Because of the misunderstanding that has arisen concerning the objectives of the certification program the Council referred it back to the committee on professional development and adopted a resolution in which it was stated that E.C.P.D. "disclaims any intention to set up a certifying agency in conflict with the legal registration of engineers . . . or to parallel or supplant the National Bureau of Engineering Registration." The latter bureau was established by the National Council of Engineering Examiners in 1932.

Further action on the subject of registration included approval of a report by the committee on professional development in which it was stated that "registration of engineers is an important element in unified approach toward establishment of adequate means for recognizing the engineer as a professional man. E.C.P.D. should therefore address itself to rendering all possible assistance to effect uniform registration laws in states which now do not have them and to improve the registration laws where they now exist."

School accrediting

Accrediting of engineering schools has been begun by E.C.P.D., as noted in our issue of Sept. 26, p. 446. In June of this year invitations were sent to the deans of engineering in all institutions in New England and the Middle Atlantic States, but because of the absence of most of the teaching staff, the actual accrediting work

was not begun until this fall. The committee in charge of the work hopes to have its initial recommendations ready for action by the council at a special meeting to be called in April.

Student selection and guidance

The committee on student selection and guidance reported that during the year it has urged the local sections of the Founder societies to organize guidance committees, and has suggested to the engineering colleges that they lead or cooperate in local guidance movements.

Professional training

The committee on professional training reported that it is making progress on the revision of its pamphlet containing suggestions to junior engineers, and that its reading list for junior engineers is being extensively revised. The major work of the committee during the past year has been the preparation of a selected bibliography of engineering subjects. This list is rapidly approaching final form.

Charles F. Scott, professor emeritus of electrical engineering, Sheffield Scientific School, was elected chairman of E.C.P.D. to succeed C. F. Hirshfeld who has served as chairman since the formation of E.C.P.D. George T. Seabury, secretary, American Society of Civil Engineers, was re-elected secretary. The new executive committee consists of Charles F. Scott, Harrison P. Eddy, C. F. Hirshfeld, L. W. W. Morrow, F. M. Becket, H. C. Parmelee, R. I. Rees, and D. B. Steinman.

SOCIETY CALENDAR

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, first annual convention, Columbus, Ohio, October 23-25.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Columbus, Ohio, October 23-25.

INTERNATIONAL ACETYLENE ASSOCIATION, annual meeting, Cleveland, Ohio, November 12-15.

HIGHWAY RESEARCH BOARD, annual meeting, Washington, D. C., December 5-6.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

AMERICAN ROAD BUILDERS' ASSOCIATION, annual convention and road show, Cleveland, Ohio, week of January 20, 1936.

WISCONSIN SECTION, AMERICAN WATERWORKS ASSOCIATION, annual meeting, Sheboygan, Wis., November 4-6.

NEW JERSEY SECTION, AMERICAN WATER WORKS ASSOCIATION, first general meeting, New Brunswick, N. J., October 30.

NORTH CAROLINA SECTION, AMERICAN WATER WORKS ASSOCIATION, and NORTH CAROLINA SEWAGE WORKS ASSOCIATION, annual joint convention, Durham, N. C., November 4-6.

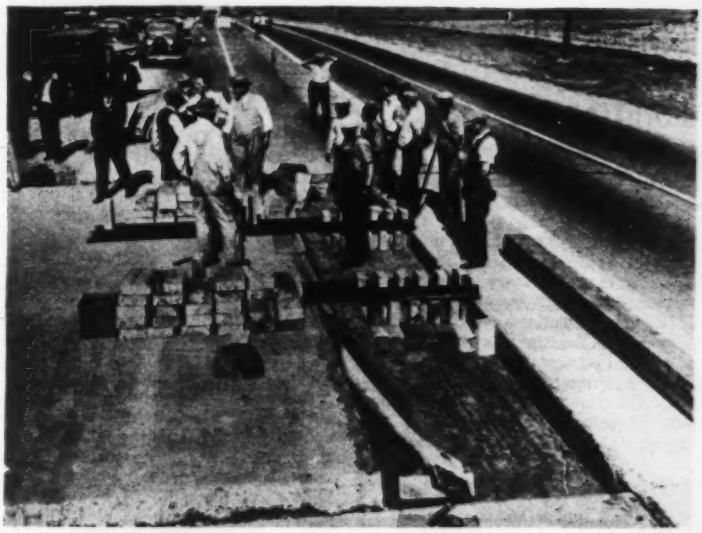
MISSOURI VALLEY SECTION, AMERICAN WATER WORKS ASSOCIATION, Des Moines, Iowa, November 6-8.

VIRGINIA SECTION AMERICAN WATER WORKS ASSOCIATION and VIRGINIA SEWAGE ASSOCIATION, annual conference, Roanoke, Va., November 7-8.

EXPOSITION OF CHEMICAL INDUSTRIES, fifteenth annual exposition, New York City, December 2-7. Metals and alloys, plastics and plant equipment will be included ameng the exhibits.

EXAMINATIONS for the registration of professional engineers will be held in the near future as follows:

WISCONSIN—Examination for the registration of professional engineers in State Architects Office, Madison, Wis., October 23-25.



JACKING A CENTER ISLAND INTO A FOUR-LANE ROAD

Because of the frequency of accidents on its four-lane Brunswick Pike (main route between New York and Philadelphia), New Jersey is separating the north and south bound traffic lanes by a safety island constructed in a novel manner. First the longitudinal and transverse joints are broken, following which a "jacking" operation is utilized to slide two lanes of pavement over until space for the center island is provided, or a total of 12 ft. Jacking pressure is provided by inflating a tube inserted along the center line joint as shown in the illustration. Each slab section weighs 30 tons. The first experiment with this method of widening involves 8 miles of road at a cost of $50,000 per mile.

Building Trades Dispute Near Settlement

The long and bitter fight waged between two groups of building trades unions for official recognition by the Building Trades Department of the American Federation of Labor appeared to be at an end on Oct. 14 when the two sides agreed to place their difficulties before a committee of six representing both sides. The agreement was reached during the annual convention of the A. F. of L. at Atlantic City, N. J., and is looked upon by labor leaders as an ending of the long struggle that broke into the open at the San Francisco convention a year ago. Pending final settlement, neither group will be regarded as official by the Building Trades Department.

A group of twelve of the smaller trades unions has been recognized by the Building Trades Department, excluding seven large unions, including the "Big Three" carpenters, bricklayers and electrical workers. The excluded group has been waging a bitter fight to obtain the balance of power. Geo. M. Harrison acted as mediator.

Montreal To Build a New Intake For Water From the St. Lawrence

Montreal is to undertake the construction of a new water intake extending far out into the St. Lawrence River at the mouth of the Ottawa River. Decision to call for bids at once was reached suddenly last week after months of discussion of means of avoiding an expenditure of $1,200,000, the estimated cost of the proposed work. This action was taken following the receipt by the city council of a report of a board of engineers which is understood to have confirmed the findings of Charles J. Desbaillets, chief engineer of the water board.

Filter Equipment Award Delayed by Court Hearing

Pending a court hearing on the contention of Filtration Engineers, Inc., Newark, N. J., that specifications for vacuum filter equipment for the new District of Columbia sewage disposal plant are unduly restrictive and thus eliminate competition, award of the contract is being withheld. Bids were received Oct. 1 from four general contractors, none of whom reported any difficulty in securing competitive subbids for the equipment in question.

Application for an injunction to force changes in the specifications was made Sept. 30 by W. Gwynn Gardiner, a former District Commissioner, acting for himself as a District taxpayer and for Filtration Engineers as a federal taxpayer. It is charged that the requirements for the vacuum filter equipment are so framed as to limit the number of possible bids and to eliminate from consideration the patented product of the complaining company.

District officials deny this charge, stating that the specifications were drawn after thorough consideration of all types of equipment, including visits to operating installations. Vacuum filters with scraper removal of sludge deposits are called for, the spring method of discharge not being considered satisfactory for conditions at the new plant. The scraper type is unpatented and can be made by any qualified manufacturer, including the complainant, it is pointed out. The choice between the two methods was dictated solely by considerations of efficiency, according to District officials.

No date has been set by the District Supreme Court for a hearing on the case. Meanwhile, no award will be made.

Metcalf & Eddy, of Boston, are consulting engineers for the $4,000,000 plant.

Pollution Standards Sought by Engineers In Health Service

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The larger awards include: two rolling mills with feeders and catcher tables, Republic Steel Corp., Warren, O., $300,000; two apartment buildings, and dormitory U. S. Engrs., Eastport, Me., $493,000; highways, $626,000 by Oklahoma; $1,341,000 by Missouri; $646,000 by Arizona; $992,000 by New York; $602,000 by North Carolina; $581,000 by Tennessee; bridges, $439,000 by Oklahoma; wells and structural steel for waterworks, 2 contracts, Milwaukee, Wis., $459,000; sewage treatment plant, contract 13, sludge equipment, contract 12, for Metropolitan Sewer District, Hartford, Conn., $579,000; port terminal, Morehead City, N. C., $349,000; and 21,842 tons steel rails for C & O Ry., $750,000.

New capital includes new state and municipal bond sales of $3,348,000 and sale by RFC of PWA bonds, $5,575,000. All PWA allotments released this week were for federal work. New capital for 1935 so far totals $2,361,043,000 compared with a corresponding figure of $1,160,342,000 last year.

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State and municipal	15,844	16,281	14,085
Total public	$18,878	$22,290	$17,392
Total private	3,747	9,173	4,580
Week's total	$22,625	$31,463	$21,972

Cumulative to date:
1934..$1,102,404,000 1935..$1,112,363,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1935	Week Oct. 17	Cumulative
State and municipal	$8,923*	$341,103
PWA allotments, S&M	—5,575*	751,562
RFC loans, S&M	....	48,180
Corporate issues	....	27,338
PWA private	457	9,086
Local contrib. to WPA	....	23,967
Total non-federal	$3,805	$1,201,236
PWA federal	22,970	1,159,817
Total new capital	$26,775	$2,361,053

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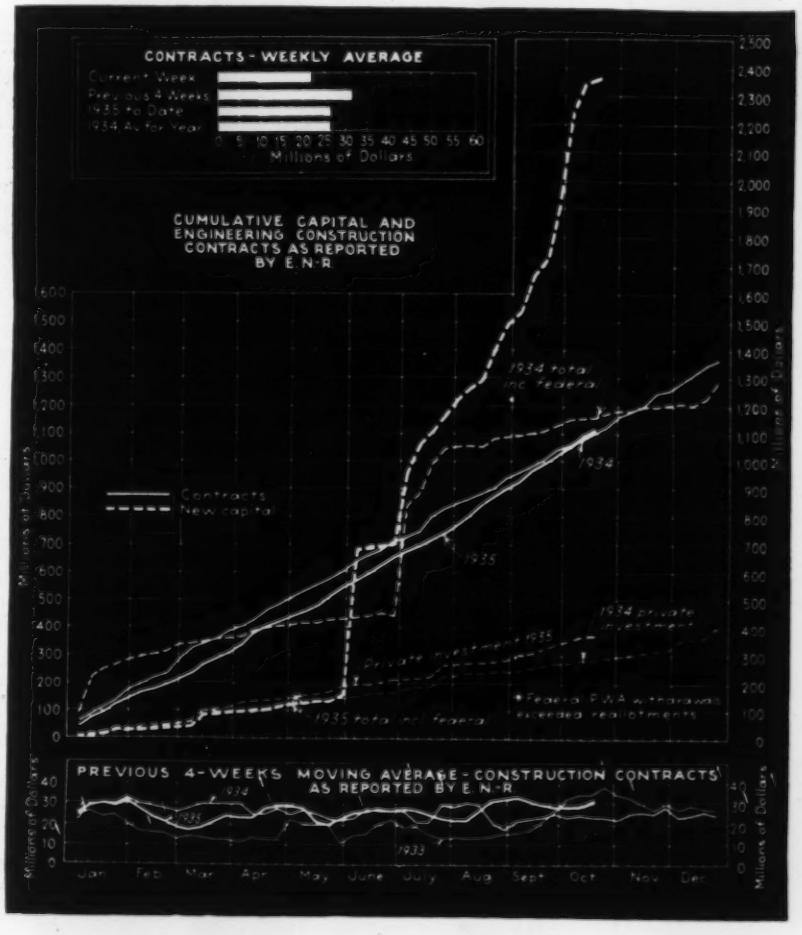

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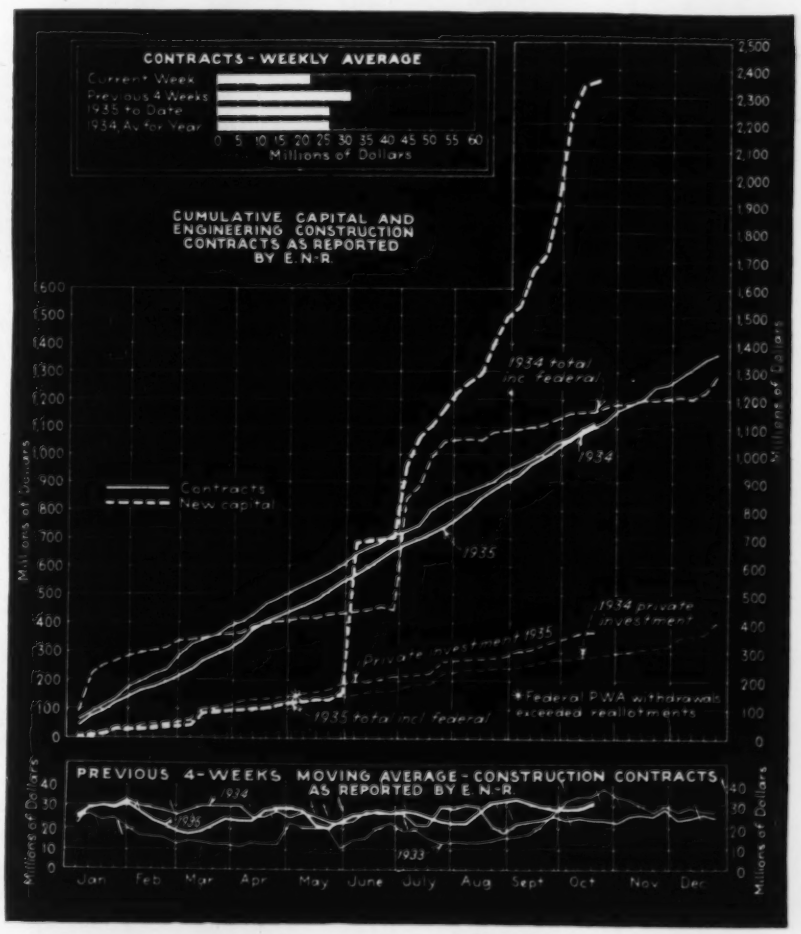
CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1935 to Date
1934 Av. for Year
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934 total inc federal
1934
1935
1934 private investment
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Contracts
New capital
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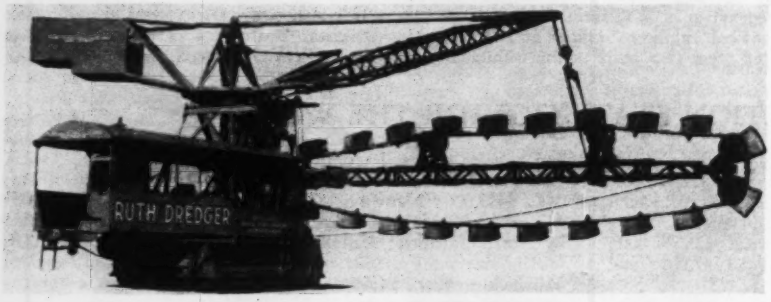
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials

New Bucket Dredge Designed For Reclamation Service

Advancements in design, made possible by the use of steel and aluminum alloys, mark the latest Ruth dredger to be put into service by the U. S. Bureau of Reclamation.

This dredger, manufactured by the Ruth Dredger Mfg. Corp., Los Angeles, Calif., and equipped with a counterweighted digging unit, was designed to comply with the specifications of the Bureau for use on the Rio Grande project to clean drain channels 60 ft. wide and 15 ft. deep, and in addition, to excavate a ditch 8 ft. wide and 2 ft. deep in the bottom of existing channels without disturbing the channel banks.



The design of the digging unit of the dredger is made possible through the use of duralumin for the entire framework of the 50-ft. digging unit and of plate aluminum for the body of the buckets. Manganese steel is used for the cutting lips and runners of the buckets. The mounting can be rotated through an arc of slightly more than 180 deg., so that the digging unit may be used on either side of the dredger, or turned to the rear when traveling from one location to another. Dual control stations facilitate operation as the operator may always be on the digging side.

The digging unit is comprised of the duralumin frame truss and 26 buckets carried on a managanese steel chain. Each bucket has a capacity of ¼ cu.yd., and the highest speed of the digging unit gives the dredger a capacity of 5 cu.yd. per minute. Each bucket is equipped with a Ruth patented cleaning device which insures positive ejection. The back end of the unit has a 5-ft. vertical and a 6-ft. horizontal movement. The lower end, suspended from the counterweighted boom, has a range of positions from horizontal to that which will cut a channel bank with a slope of ½ to 1. At the upper end provision is made for attaching a conveyor or chute. The lower end of the digging unit has a patented adjustable pivoted arm that enables it to dig the bottom of a ditch either flat or V-shaped. As this arm is in contact with mud, the gears operating it have special self-cleaning teeth.

The dredge is mounted on a traction unit of two caterpillar tracks 40 inches wide and 16 feet long driven from the central diesel power plant. The drive to the tracks is through manganese steel sprockets engaging directly with manganese steel track links, thus doing away with an inside chain drive. The transmission gives six speeds forward and six reverse speeds for the traction unit and four speeds for the digging unit. The gears in the dredger are made of high-strength alloy steels, fully enclosed and sealed from dirt and water. The total weight of the machine is very close to 100,000 lb.

Four Concrete Mixer Companies Acquire Powell Licenses

The status of the Powell Process patents, covering the basic process involved in manufacturing and transporting central-mixed concrete in closed agitator trucks, has been settled by the negotiation of contracts between the Powell Co. and four manufacturers of concrete mixing bodies. The following companies now have complete Powell patent coverage for the life of such concrete mixing bodies as they manufacture: Blaw-Knox Co., Chain Belt Co., Jaeger Machine Co., Ransome Concrete Machinery Co. It was the original plan to interest the producers of central-mixed concrete in an association of licensees to promote this process for general use. When these plans did not materialize the Powell Co. concluded to work out its plan by licensing these four companies for full coverage for the life of the mixer bodies sold by them during the length of the agreement.

Time Record of Water Used Made Available by New Device

A flow recording device which can be attached to any type or size of water meter, including compound meters with two registers, so as to provide a permanent record of the amount of water passing at any instant, is now available. It has been named the Meter-Master, by the manufacturers, Brainard & Hatch, Hartford, Conn.

It records by positive mechanical means the time a flow starts, when it stops, and the variations in the rate of flow. As regularly furnished, the record may be made for a period of 24 hr. or 6 hr., as may be desired.

The Meter-Master can be used to tell the consumer why his bill is higher than he thinks it should be, and for what he is using the water.

The Meter-Master can be used to determine the necessary size of meter, thus reducing meter costs.

New Munsell Vibrators Eliminate Flexible Shaft

Two newly developed air-driven vibrators, made by Munsell Concrete Vibrators, Jersey City, N. J., are so designed as to eliminate the necessity of expensive flexible shafts. Type E-1 is equipped with a cross handle ¾ in. in diameter. A convenient valve regulates the flow of air into the vibrator. The inflow pipe is placed in a 2½ in. hose which serves also as an exhaust. The more rigid construction of this model allows it to be directed under cross members in structures.

Another model, Type E-2, is equipped with a ¾ in. air line controlled from the compressor. This model can be used in any depth of forms as additional air line can be added as needed. These models are 5 in. in diameter at the largest circumference and are 6 ft. in overall length. Because of the oval shape of the vibrating unit they will reach into close places without catching on irregularities in the forms. Frequencies of 3,500 to 4,500 can be attained with from 80 to 90 lb. of air.

Electric Backfill Tamper Converted Into Digging Tool

Especially designed for backfill tamping, the Jackson backfill tamper made by the Electric Tamper & Equipment Co., Ludington, Mich., delivers from 1,500 to 1,800 blows per minute. The tamper is operated by a 1 hp. 3-phase induction motor which operates a striking cam on the rotor shaft. Either conical or flat tamping discs of 6, 8 or 10-in. diameter, for use in materials of varying density and cohesion, can be furnished with each machine. The tamping disc is easily replaced with a digging blade, and the machine is converted into an efficient digging tool for clay and asphalt.

Business Notes

BLAW-KNOX CO., Pittsburgh, Pa., announces that James B. Allington, formerly of the Rochester Gas & Electric Co., Rochester, N. Y., has joined the sales force of the Blaw-Knox Co. at Pittsburgh.

THE CATERPILLAR TRACTOR CO., Peoria, Ill., has recently announced personnel changes: Paul Weeks, formerly manager of the Washington office, is to become manager of the special sales division, succeeding Walter H. Gardner, who leaves to become general sales manager of Keystone Steel & Wire Co. C. L. McMullen will have charge of engine sales, and G. E. Spain will have charge of power unit sales to distributors and dealers.

THE BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa., has appointed R. P. Kilsby as western sales manager. Mr. Kilsby, who was formerly attached to the general sales office, will now make his headquarters at the Chicago office.

THE AMERICAN CONCRETE EXPANSION JOINT CO., Chicago, Ill., has recently appointed George E. Hillsman as sales manager.

WESTERN CATAPHOTE CO., Toledo, Ohio, has been appointed national distributors for Tyton guard rail and Berloy plate guard rail by the Berger Manufacturing Co., division of Republic Steel Corp., Canton, Ohio.

THE FULLER CO., Catasauqua, Pa., has acquired from F. L. Smidth & Co., the exclusive rights to the Fluxo system for conveying cement and other pulverized materials, in the U. S., Canada and Mexico.

GEORGE RAPP has been elected president of the newly formed Kentucky Rock Asphalt Institute. Mr. Rapp is vice president of the Ohio Valley Rock Asphalt Co., and is also a member of the American Society of Civil Engineers.

ELECTRO METALLURGICAL SALES CORP., New York City, announces that John D. Swain has been elected vice president. Mr. Swain has been vice president of the Linde Air Products Co., and Union Carbide Sales Co. prior to his present position.